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ELECTRICAL WORLD

McGraw-Hill Publishing Company, Inc.

FEBRUARY 6, 1932
25 cents per copy

"Today
I leave you; I go to
assume a task more difficult than
that which devolved upon General Washington . . . If the same Almighty arm that
directed and protected him shall guide and
support me, I shall not fail; I shall succeed." ¶ So
spoke Abraham Lincoln on the morning he left
Springfield for Washington, for his first inauguration.
¶ Today we, as a nation, have a difficult situation to
face. But because the will-to-do which animated Lincoln is part of our heritage, we too can say with
him..."we shall not fail; we shall succeed."

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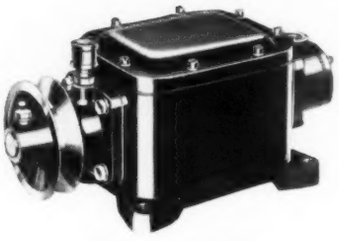

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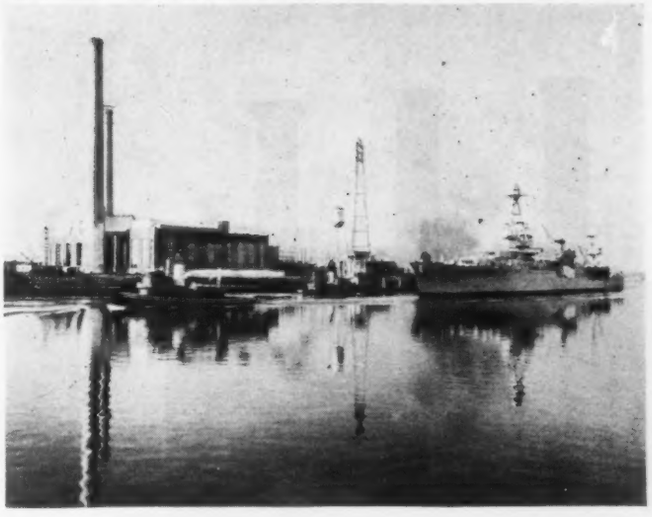

Deepwater station
Houston Lighting & Power Co.
U. S. cruiser Houston passing by.

FEBRUARY 6, 1932

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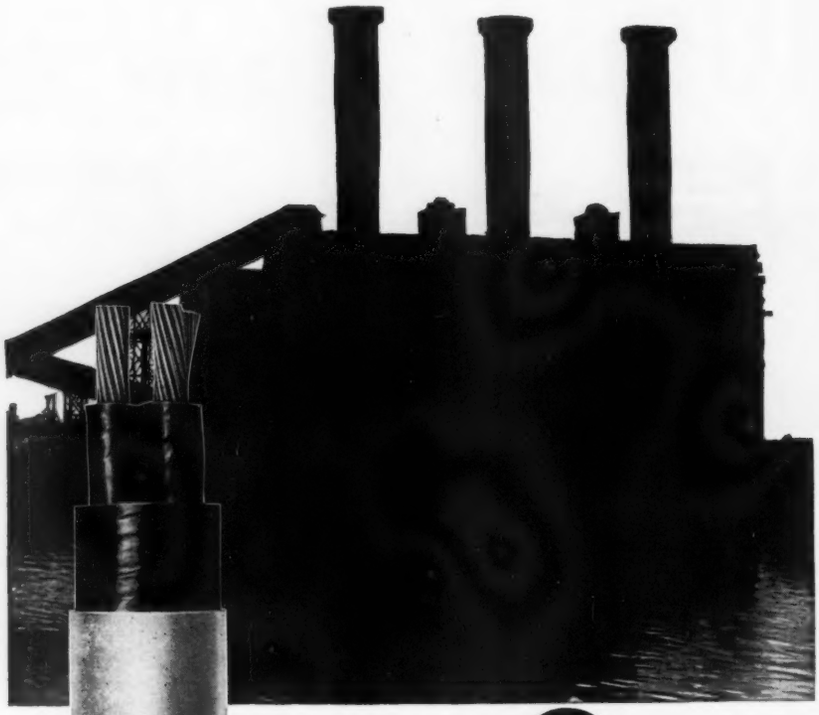

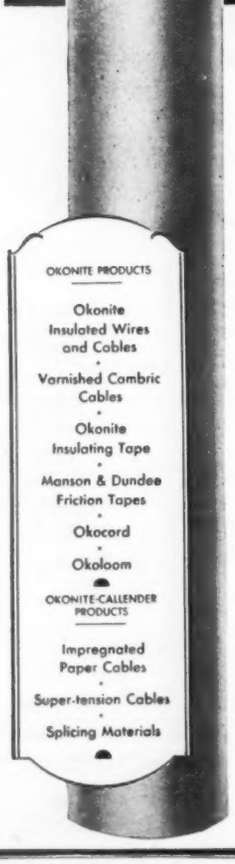

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ELECTRICAL WORLD

Established 1883. McGraw-Hill Publishing Company, Inc.

for the Week Ending

February 6, 1932

Only 15 per cent of the appliances sold last year were sold by central stations. In my company the kilowatt-hour consumption for domestic customer service jumped 40 per cent in the three years we sold appliances, and the rate was reduced 35 per cent in the same time. The field is far from saturation. Merchandising done by the central station creates more demand for appliances and means more business for the dealer.

J. F. OWENS,
President N.E.L.A. and
Oklahoma Gas & Electric Co.

[Mr. Owens addressed the Electrical Association of Philadelphia last week.]

—**Utility commissioners protest** that regulatory representatives and their associations should be free of utility-leader influence and that certain reforms should be initiated which were tabled at convention last fall—*p. 252.*

Utility men plead against new levy

—**Industry opposes proposed tax** which is sponsored by Representative Crisp. Leaders present utility side and show probable burden upon all industry and homes of nation—*p. 250.*

—**Federal Trade investigators** unearth more "write-ups." This time the National Electric Power Company is charged with boosting Penn Central values when that property was absorbed—*p. 251.*

A.I.E.E. had diversified program

—**Over 1,350 electrical engineers** assembled in New York for the winter convention of the A.I.E.E. Many papers reported in abstract in this issue. Several new devices and developments were announced at the meeting—*p. 266.*

—**Lightning troubles are fading** as investigations of fundamental causes of outages encompass hitherto neglected factors. Distribution transformers of small size and considerable age are among the danger points—*p. 280.*

—**Oil-breaker theories debated** long and earnestly. Oil-blast and Deion adherents still diverge on supposed fundamentals. Dr. Slepian discusses the matter at some length—*p. 282.*

—**Fault-elimination promptness** cited as the essential for operating stability of interconnected systems. Loose-linking and synchronizing at the load used for metropolitan systems—*p. 276.*

Financing resumed on small scale

p. 256.

Proposed Tax on Consumption of Energy Is Attacked from Many Sides

SPOKESMEN for the electrical industry and representatives of large consumers of electrical energy appeared before the ways and means committee of the House of Representatives at Washington on February 3 and urged that a tax on consumption of electricity would be unjust and discriminatory as well as disappointing from a revenue-producing standpoint. The point was also made that a percentage tax upon electric power bills would penalize small industrial plants that are not in a position to generate their own power. Larger competitors of these plants, on the other hand, could evade the tax by generating their own power.

At the outset of the hearing Representative Crisp of Georgia, acting chairman of the committee, made it clear that no proposal for a tax of one-half cent per kilowatt-hour is now being entertained. Mr. Crisp conceded that such a tax would be unreasonable and confiscatory. For the benefit of those who attended the hearing, he stated that the only proposal under consideration was one for a tax of somewhere between 1 and 10 per cent to be applied upon electric power bills for domestic and industrial uses. This tax would be assessed against the customers of municipally owned power companies as well as against those of privately owned power companies.

Mr. Crisp explained that the Federal Trade Commission has computed that a 5 per cent sales tax on electricity would yield a revenue of $107,000,000 a year. In arriving at this estimate, the Federal Trade Commission acknowledged reliance on consumption figures compiled by the ELECTRICAL WORLD for the calendar year of 1931.

William J. Hagenah, representing the National Electric Light Association, said that the figures used by the Federal Trade Commission are correct, but that the conclusions are entirely wrong. He emphatically denied that a 5 per cent sales tax would yield anything like the revenue estimated by the commission. He called attention to the fact that 26 per cent of the total amount of electric power utilized by the nation's manufacturing plants is produced by the plants themselves. A tax paid by factories and business concerns which use purchased electric power and not paid by similar concerns using power from other sources would be unequal and discriminatory, he said. A tax on the bills of domestic consumers would affect 80 per cent of the nation's homes and would fall directly on essentials of living, such as lighting, heating, cooking, food preservation and household labor-saving devices.

William H. Onken, Jr., vice-president Security Owners' Association, said that the proposed tax would in the last analysis fall on the poor rather than the rich, pointing out that insurance companies and savings banks hold securities of electric utilities alone amounting to two billion dollars.

On behalf of the American Electric Railway Association, C. D. Gass informed the committee that the tax added to the total yearly power bill of $49,374,000 paid by the electric railways of the country would put a severe burden on the operation of these companies. A communication to the committee from the Detroit Municipal Railway registered the complaint that this line would be required to pay an additional amount of $160,000 a year on the energy that it buys from the Detroit Edison Company if a 10 per cent sales tax were assessed. In this connection Representative Crisp observed that the courts have already established that a tax can be levied on proprietary enterprises carried on by a municipality or state which cannot be regarded as purely public functions.

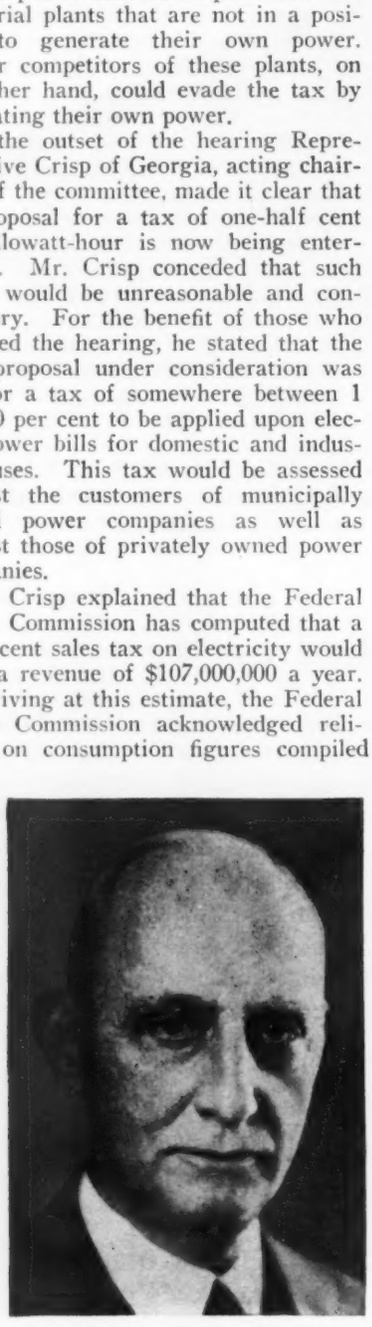
Others who argued against the proposed tax included L. S. Storrs, chairman of the board of the United Railways of Baltimore; E. J. McIlraith of the Chicago Surface Lines, and H. M. Payne, representing the American Mining Congress.

▼

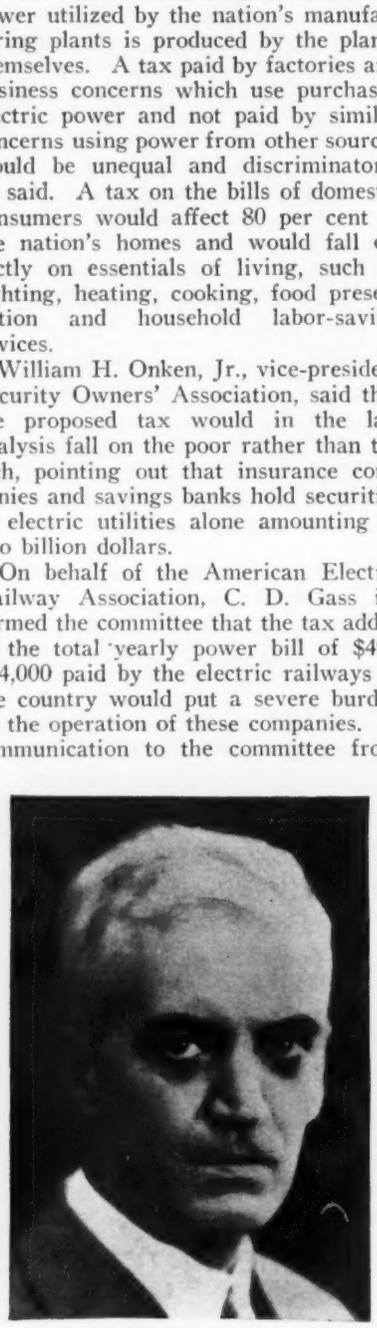
Smith Made President of New York Edison

His election followed by that of J. C. Parker for Brooklyn Edison and that of H. L. Snyder for Queens

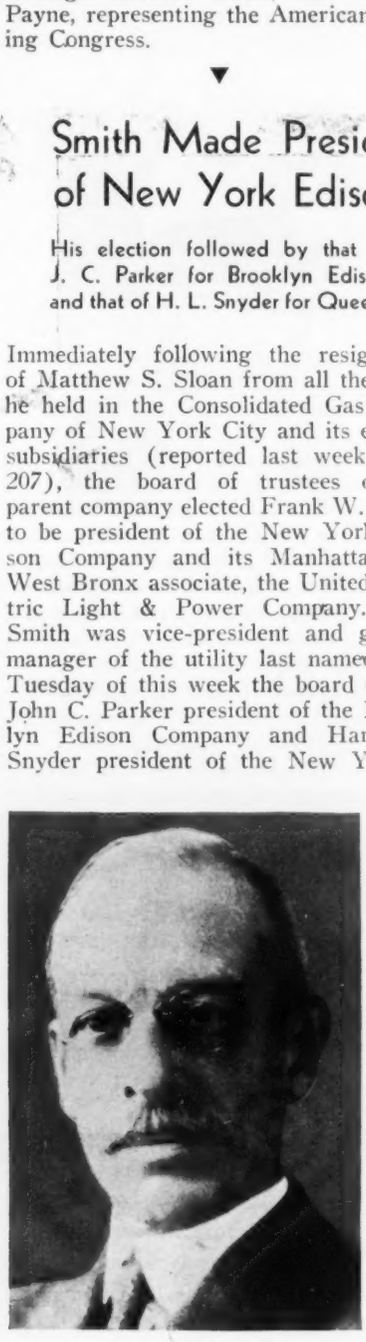
Immediately following the resignation of Matthew S. Sloan from all the posts he held in the Consolidated Gas Company of New York City and its electric subsidiaries (reported last week, page 207), the board of trustees of the parent company elected Frank W. Smith to be president of the New York Edison Company and its Manhattan and West Bronx associate, the United Electric Light & Power Company. Mr. Smith was vice-president and general manager of the utility last named. On Tuesday of this week the board elected John C. Parker president of the Brooklyn Edison Company and Harry L. Snyder president of the New York &



Frank W. Smith



John C. Parker



Harry L. Snyder

Queens Electric Light & Power Company. Mr. Smith was recently succeeded as president of the Yonkers Electric Light & Power Company by E. H. Rosenquest, who also heads the Westchester Lighting Company.

This week also Philip Torchio, senior vice-president of the New York Edison Company, was elected to be also senior vice-president of the United Electric Light & Power Company. Robert B. Grove, vice-president of United Electric Light & Power, was elected a vice-president of the New York Edison, and William W. Erwin, controller of the New York Edison, was elected vice-president of both companies. In addition, E. P. Prezzano has been made executive vice-president of the Yonkers utility, the same post he holds with the Westchester Lighting Company, and Stuart Wilder, vice-president of the Westchester and Bronx utilities, and W. L. Diehl, their secretary, have assumed the same posts respectively with the Yonkers company without relinquishing their prior offices.

It is believed that further unification is planned in the Consolidated Gas group of light and power utilities and that the appointment of identical officers for separate units serving contiguous territory, as in the two instances just mentioned, constitutes a step in that direction.

Career of the new presidents

Though his years are only 64, few active executives in the central-station field have had a longer business career than Mr. Smith, who entered the service of the United States Illuminating Company in 1880 as a boy of twelve, two years prior to the opening of the famous Pearl Street station. In 1889 he was appointed paymaster for the United Electric Light & Power Company, successor to the United States Illuminating Company. In 1891 he was made assistant auditor of the company, and in 1898 he was elected assistant secretary. A year later he was elected secretary of the Brush Electric Illuminating Company, of which he is now president and a director. In 1905 he became secretary of the United Electric Light & Power, and in 1912 vice-president, being appointed general manager in 1916.

Mr. Parker became vice-president in charge of engineering of the Brooklyn Edison Company in 1926. He joined that company in 1922 as electrical engineer. Previously for seven years he was professor of electrical engineering at the University of Michigan, following a varied experience with manufacturing and power companies and as a member of the teaching staff of Union College, Schenectady.

Mr. Snyder, vice-president and general manager of the New York & Queens Electric Light & Power Company since 1925, has been interested in Queens Borough utilities since 1899, when he assisted in a merger that preceded the present organization in that territory.

▼

Most S. E. D. Activities Are to Be Discontinued

The board of directors of the Society for Electrical Development, at a special meeting the end of last week, called to consider the financial position of the organization, decided to reduce the staff to three persons, which involves the general discontinuance of former activities. A tentative budget was set which it is proposed will be financed directly by the four major national associations of the electrical industry, to which associations the recommendations are now being submitted.

▼

"Write-ups" Again Figure in Federal Trade Inquiry

When the Federal Trade Commission resumed its inquiry into the utility companies on Thursday of last week Aaron J. Hughes, one of the commission's investigating accountants, took the stand to give the results of his examination into the affairs of the National Electric Power Company, an Insull holding organization. Some of the evidence which he presented is thus summarized:

The National Electric Power Company carried 459,981 shares of its own common stock on its books, issued for other companies, as a purely nominal liability. At the same time 297,409 other shares of common stock, issued for cash, were carried as a liability of $8,391,735.

In 1926 Insull, Son & Company, Inc., purchased stock of the National Electric Power Company with funds supplied through sale of $15,000,000 of notes of Insull, Son & Company to the Middle West Utilities Company. Insull, Son & Company received a fee of $250,000 for turning control of National Electric Power Company over to Middle West Utilities Company.

In 1928 an excess over book value of $20,309,514 was paid by the National Electric for stocks of subsidiaries, and in 1929 the excess was $22,499,037. The percentage of retirement reserve to fixed capital of the group at the end of 1925 was 5.29, and at the end of 1929 it was 7.11 per cent. Revenues from utility services in 1926 were 16.07 per cent of fixed capital, and in 1929 they were 15.66 per cent, he stated. Depreciation reserves set aside in 1926 were 7.8 per cent of gross operating revenues and in 1929 they were 5.64 per cent.

Reorganization of the Penn Central Light & Power Company, incidental to its acquisition by National Electric Power Company by means of a temporary corporation set up for the purpose, resulted in an increase of fixed capital of nearly $6,000,000 on the books of the new company, "which was in effect a 'write-up,' though technically an original entry."

Basic Material Output Still at Low Level

STEEL ingot production for the country as a whole suffered a further slight recession to 28 per cent of capacity against 29 per cent a week ago, "Iron Age" estimates. More price recessions on sheet steel are reported. Pig-iron output for January dropped to a new low level. Copper prices receded further and now approximate an all-time low. Commodity prices in general also weakened slightly this week.

Settlement of the railway wage dispute, although a decidedly favorable factor, does not necessarily infer any large increase in railway purchases at the moment, it is thought. Such purchases in the near future, however, are expected to be a large factor in business revival.

Electric output showed a smaller decline for the last week of January than for previous weeks.

The National Electric Power brought about the acquisition by Penn Central of a group of five small utility companies which were obtained by contracts in June, 1927. These companies were carried on the books of the vendors at $1,847,865, but were recorded by Penn Central on the basis of an appraisal at $5,523,332.

On the basis of the appraisals, the Penn Central acquired for $733,660 net assets which it carried on its books at $4,320,110. This resulted in an appreciation of $3,675,467.

The National Electric Power made a profit of $150,000 in the purchase and sale of seven small companies to Penn Central, and these properties were subsequently carried on the books of Penn Central at $1,400,510 in excess of the amount at which they had been carried on the books of the vendor companies.

Four other companies acquired by Penn Central were recorded at $69,093 in excess of their value on the books of the vendor companies.

On Tuesday of this week Mr. Hughes testified that as a result of the acquisition of the Ohio Electric Power Company in 1925 by the National Electric the latter company took a profit of approximately $367,000 through the sale of property and securities. The Ohio Electric subsequently sold part of these same assets at a profit of more than $300,000, he stated.

The commission also heard testimony relative to other subsidiaries of the National Electric Power Company. One of these, the Michigan Electric Power Company, Mr. Hughes testified, yielded earnings of 36.7 per cent in 1928 and 15.5 per cent in 1929 on the National Electric's investment in its common stock.

State Commissioners Find Fault with Their National Association

California, New York, Wisconsin and Oklahoma regulatory bodies would bar utility men from attendance at conventions and would hold all meetings at Washington.

CHARGING that the National Association of Railroad and Utilities Commissioners as it is now conducted is "imperiling state regulation," the members of the Railroad Commission of California and the Public Utility Commission of Wisconsin, together with Chairman Milo R. Maltbie of New York, have served formal notice upon the membership of the national association of their intention to secede unless the association "changes its course." The commissioners concerned have made announcement of this intention in a communication addressed to the utility commissioners of the various states. The Oklahoma Corporation Commission, which is understood to sympathize with the point of view of the protesting regulators, may prepare a separate memorandum. The grounds for the protest, as stated by the California commission, are threefold:

First—It is charged that at the annual meetings of the national association a number of utility officials and representatives have endeavored to "influence the action in the convention by furnishing entertainment to commissioners and by other similar activities and have seriously impaired the value of the conventions and are bringing the good name of the entire association into disrepute." It is stated that this condition has "reached such proportions that corrective measures must be applied." The communication points out that a resolution intended to remedy this condition and "to discourage the attendance of the large number of utility officials and representatives who have regularly been invited to attend these yearly meetings" was overwhelmingly defeated at the last convention. Further objection is registered to the action of the association, because it "voted to suppress and exclude from its public records the transcript of the debate on this issue."

Second—Formal opposition is voiced to the action of the association at its last convention in defeating a resolution providing that the yearly convention be held permanently, after 1932, at Washington, D. C. This resolution, offered by President Clyde L. Seavey of the California Railroad Commission, was designed to abolish the "junketing aspects" of the gathering.

Third—Objection is taken to the action of the national association in continuing the "supervision" of the publications *Public Utilities Fortnightly* and *Public Utility Reports*. The point is made that, though these publications are valuable ones, the association should not indorse and supervise a publication owned and operated by utility interests. A resolution to this effect was moved at the Richmond convention last fall by Chairman Milo R. Maltbie of the New York commission, but was laid on the table.

▼

South Carolina Energy Tax May Be Radically Changed

A bill has been introduced in the South Carolina House of Representatives to amend the act of 1931 imposing a tax of one-half mill per kilowatt-hour on all electricity generated or sold within the state. The amendment would increase the tax to 1 mill. The legislative committee has recommended that the law be amended to provide for application of the tax only at the point of sale, thus eliminating the tax on exported power.

▼

Merchandising Conference With Minnesota Retailers

Meetings of the Commercial Section of the North Central Electric Association, of the Minnesota Retail Hardware Association and of the Electrical Contractor-Dealers of Minnesota were held at St. Paul last week, culminating in a joint conference addressed by Thomas B. Howell, president of the National Retail Hardware Association; Earl Peak of Marshalltown, Iowa, representing the Association of Electragists; William Hodge, vice-president of H. M. Byllesby & Company, and Earl Whitehorne of the McGraw-Hill Publishing Company.

The joint session developed a frank discussion of the relationships between the power company and the hardware dealer in the local merchandising situation and the opportunity for adjustment of conflicting policy through local contact and conference. Mr. Howell said that although the hardware association has been working with the power industry in a spirit of conciliation, it is determined to obtain relief from present competitive conditions, even if it is necessary to fight for legislation in each state to prohibit the power companies from merchandising.

The mutual dependence of the hardware and power-company men was stressed by Mr. Whitehorne, who pointed out the extent to which the power company's proficiency in pioneering appliances, based on experience, supplements the superior ability of these dealers in merchandising and the importance to the local merchant of keeping the power company in the appliance business to do this pioneering job.

▼

ENERGY TO SERVE LONDON FLOWS UNDER THE THAMES

—*Wide World Photos*

Inspecting the junction boxes of the 66,000-volt cable carried under the Thames River to the Battersea power station, one of the largest in Great Britain, now approaching completion as a very important factor in serving London and the metropolitan district.

Three Illinois Utility Associations Amalgamate

Consolidation of the Illinois State Electric Association, the Illinois Electric Railway Association and the Illinois Gas Association into one body, to be known as the Illinois Public Utilities Association, has been announced. A. D. Mackie, vice-president of the Illinois Power Company, Springfield, was named as chairman of the executive board. He was previously the president of the Illinois State Electric Association. The three associations had long maintained close relations and had the same secretary. That post will now be filled by John R. Blackhall, Highwood, Ill. Decision on whether to hold a convention this year was deferred.

▼

Indiana Rate Questions Are Far from Settled

An injunction has been issued by a federal court in Indianapolis to the Indiana General Service Company as a result of the Public Service Commission's refusal to grant a rehearing on the reduction of 20 per cent ordered in electric rates at Marion. The suit will be based on the issue of confiscation.

The temporary electric rates ordered by the Indiana board for 76 cities and towns in southern Indiana (ELECTRICAL WORLD, January 30, page 208) have not been accepted unanimously by the cities themselves. Lebanon and other cities have notified the Public Service company that they will seek still lower rates.

Mayors of 24 Indiana cities met recently at Martinsville and outlined a tentative program designed to curb expansions and reduce profits of all utilities in Indiana. A permanent organization is sought.

▼

Reduced Electric Rates Are Authorized in Ohio

Reduced electric rates for residential and commercial lighting have been authorized by the Ohio Public Utilities Commission for seven companies, serving 41 cities and villages in the western part of the state.

The companies are the Ohio Electric Power, Buckeye Light & Power, Greenville Electric Light & Power, Eaton Lighting, Brookville & Lewisburg Lighting, New Madison Lighting and Bradford & Gettysburg Electric Light & Power. The rates became effective as of January 1.

The Dayton Power & Light Company has asked the commission to approve a schedule of rates for residential consumers, effective March 1, reducing the charge for the first 30 kw.-hr. per month from 7 to 6½ cents.

▼

For Limit to Jurisdiction of U. S. Courts on Rates

A bill to deprive district courts of the United States of a part of their jurisdiction of cases in which it is sought to restrain orders of state administrative boards relating to public utility rates was introduced in the Senate January 25 by Senator Johnson of California

The measure, which is similar to bills introduced in the Lower House at several recent sessions of Congress, would deprive the federal lower courts of jurisdiction to hear cases relating to orders of state commissions when the orders (1) affect rates chargeable by public utilities, (2) do not interfere with interstate commerce, and (3) have been made after reasonable notice and hearing, and "where a plain, speedy and efficient remedy may be had at law or in equity in the courts of such state."

▼

Coeur d'Alene Vote Favors Municipal Ownership

Citizens of Cœur d'Alene, Idaho, voted very recently, by the requisite two-thirds, approval of a bond issue of $650,000 for purchase or construction of municipal electric service and water systems. A vote of 1,704 in favor of a municipal electric system against 618 was cast, this vote being almost identical with the vote last spring when the present City Council members were elected on a municipal ownership ticket. The vote is not mandatory, but gives the Council authority to proceed at its discretion.

As, under the prevailing Idaho law, condemnation of existing private utilities is not possible, the pursuance of a municipal ownership policy would mean that the community either would have to build plants to compete with the Washington Water Power Company or else persuade it to sell the existing plants.

The commission asked the Washington Water Power Company to put in effect in Cœur d'Alene in January the commercial light and power rates it recently granted to Pullman, Wash. The company agreed to do this, although it means a loss of revenue, but, as the Idaho law does not permit a rate increase without a hearing, it will be necessary for the commission to hold one before the new rates can take effect.

Coming Meetings

Process Heating Conference — Case School of Applied Science, Cleveland, Feb. 10-12. W. R. Veazey, Case School, Cleveland.

National Electric Light Association—Group committee meetings: Accounting National Section, Statler Hotel, St. Louis, Feb. 15-17; Commercial National Section, Edgewater Beach Hotel, Chicago, March 22-24. A. J. Marshall, 420 Lexington Ave., New York.

Great Lakes Division, N.E.L.A.—Sales conference and Commercial Section, Edgewater Beach Hotel, Chicago, Feb. 18-19; Engineering Section, Sherman Hotel, Chicago, April 13 and 14. R. J. Malcomson, 72 W. Adams St., Chicago.

Northwest Electric Light and Power Association — Commercial Section, Multnomah Hotel, Portland, Ore., Feb. 18-20; Berkeley Snow, 1206 Spalding Building, Portland. Engineering Section, Heathman Hotel, Portland, April 13-15; H. H. Schoolfield, Pacific Power & Light Company, Portland. Accounting Section, Davenport Hotel, Spokane, Wash., April 18-19; W. F. Miller, Washington Water Power Company, Spokane.

National Association of Purchasing Agents—Public Utility Group, Birmingham, Ala., Feb. 18-20. G. A. Renard, 11 Park Place, New York.

North Central Electric Association—Engineering Section, St. Paul Hotel, St. Paul, Feb. 22 and 23. J. W. Lapham, 803 Plymouth Bldg., Minneapolis.

Oklahoma Utilities Association—Tulsa, Okla., March 8 and 9. E. F. McKay, 1020 Petroleum Bldg., Oklahoma City.

American Institute of Electrical Engineers—District meeting, Milwaukee, March 14-16. F. L. Hutchinson, 33 West 39th St., New York.

Maryland Utilities Association — Lord Baltimore Hotel, Baltimore, April 8. D. E. Kinnear, 803 Court Square Bldg., Baltimore.

New England Division, N.E.L.A.—Safety conference, Boston, April 8. Miss O. A. Bursiel, 20 Providence St., Boston.

Arizona Utilities Association—Tucson, Ariz., April 13-15. J. S. Arnold, Central Arizona Light & Power Co., Phoenix, Ariz.

Southeastern Division, N.E.L.A. — Old Point Comfort, Va., April 20-22. C. M. Kilian, 508 Haas-Howell Bldg., Atlanta.

Southwestern Division, N.E.L.A. — Arlington Hotel, Hot Springs, Ark., April 25-28. S. J. Ballinger, San Antonio Public Service Co., San Antonio.

Missouri Association of Public Utilities —Excelsior Springs, Mo., April 28-30. F. D. Beardslee, 315 N. 12th St., St. Louis.

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Federal Power Commission Explains Lockport Ruling

A resolution by Senator Wagner calling upon the Federal Power Commission to explain to the Senate its reasons for refusing to receive the application of the city of Lockport, N. Y., for a license to use 275 sec.-ft. of the unallocated water power of the Niagara River was reported favorably by the interstate commerce committee. Senator Wagner believed that the commission was not acting in accord with the terms of the water-power act when it rejected the application of the city, because a provision in the act requires the commission to give a preferential status to applications made by states and cities, other things being equal.

The commission explained that the

20,000 sec.-ft. which may be diverted from the river under the treaty of 1910 all has been assigned to the Niagara Falls Power Company and that the provision giving preference to municipalities and states in the allotment of power rights could not be invoked. Commissioner McNinch's written opinion says:

"The commission clearly recognizes and is in accord with the purpose and intent of the statute to give preference to states and municipalities if and when there is a conflict of applications before any priority has been attached, but is of the opinion that the city of Lockport has not, under the facts now before the commission, initiated any right to the statutory preference, and that, therefore, the commission is unable to entertain or consider such application at this time."

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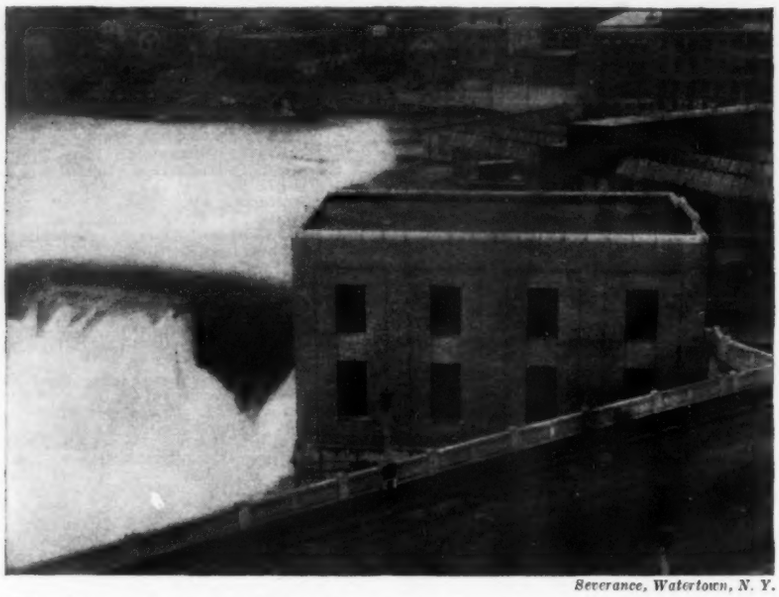
WATERTOWN, N. Y., GETS ANOTHER HYDRO PLANT



Severance, Watertown, N. Y.

Nearly twenty years' litigation over water rights preceded erection of the 10,000-hp. Beebe Island plant at Mill Street Falls, on the Black River, Watertown, N. Y., now almost ready. The Northern New York Utilities, which already has numerous small hydro plants at or near Watertown, will buy all the surplus power.

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Drought Conditions in Southeast Are Relieved

Hydro-electric power conditions in all of the Southeast have been greatly improved by unusually frequent and extensive rains occurring since early December, a traveling correspondent of the ELECTRICAL WORLD reports, and with few important exceptions storage reservoirs are either at or above normal for this season of the year, with the streams feeding them flush and pond stages raising. Virtually all reserve steam plants have now been shut down, since the hydro developments are able to carry the present load on the several power systems and permit building up water reserves at satisfactory rates; but to what extent the ground-water reserves that were so seriously depleted by two dry years have been replenished remains to be seen.

With high water in the James River enabling Richmond to operate all four of the turbines in the electric plant at Hollywood, the city is now selling power to the Virginia Electric & Power Company for the first time since September. Heavy rains have brought a steady rise in the river. Under its agreement the power company must purchase from the city up to 2,000 kw.-hr. daily when the city can operate its Hollywood plant.

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No Drought Threatened in California This Year

A special early bulletin for selected California stations of the United States Weather Bureau gives a report as of January 1 which seems to remove all fear of drought conditions in the coming summer for hydro-electric plants. The report says:

In so far as generalizations for entire stream basins and state-wide territory can be made from the limited stations for which data are available, the precipitation to January 1 is indicated to be from 50 to 60 per cent above normal from the upper Sacramento basin south through the Mokelumne basin, and from 80 to 100 per cent above normal from the Tuolumne to the Kern basin, with a general average of 70 per cent above normal from the upper Sacramento to Kern basin. In the Los Angeles, San Gabriel and Santa Ana basins the indicated general average is around 110 per cent above normal.

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Dix River Reservoir Full, Kentucky Drought Over

For the first time in very many months the Dix River reservoir of the Kentucky Utilities Company is full, water behind the power dam reaching a 247-ft. level on January 29, when the floodgates recently installed were raised to prevent loss over the spillway. During 1930 and 1931 the lake was generally far below capacity.

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Rate Disputes Persist in New York and Westchester

"Systematic investigation" of the rates of the New York Edison Company and its affiliates was again asked by Bainbridge Colby, representing the Washington Heights Taxpayers' Association, in a brief filed with the State Public Service Commission last week. The ex-Secretary of State declared the companies' concessions to be "totally inadequate," discriminatory and oppressive to the small consumer, condemned the schedule as the result of give-and-take negotiations and expressed the opinion that a reduction of $14,000,000 in the revenues of the New York Edison Company and the United Electric Light & Power Company alone should have been effected, instead of the estimated $2,500,000.

In the company's brief, filed the next day, stress was laid on the point that "it would be improper to interrupt the fair and adequate trial of the uniform rates now in force, and most unwarranted to divert time and money to rate hearings in the present state of public treasuries and utility business." A year's trial of the present rates was insisted on.

Fighting is being carried on also over the rates of the Westchester Lighting Company, still in process of adjustment before the commission, the city of New Rochelle insisting that the company's proposed 23 per cent cut is wholly insufficient and asking that the $1 minimum bill cover 10 kw.-hr. instead of 5 kw.-hr. Protest against the authorized Niagara Hudson-New York Edison interconnecting overhead line was also maintained by the Board of Supervisors of the county, the Park Commission and many associations and private citizens.

Financing Conditions Revert to 1921 Practice

FINANCING in the utility field seems to have shifted back to practices of a decade ago. After a ten-year decline in the yields of all classes of securities an era of high coupon financing comparable to that of 1920-21 has apparently returned. The bankers are proceeding on a more cautious basis. Dealers are said to be placing their share of an issue before accepting their allotment from the originators, instead of ordering a definite amount under the assumption that it could be distributed. And in one case, a Kansas Power & Light issue, rigid sinking fund provisions have been set up.

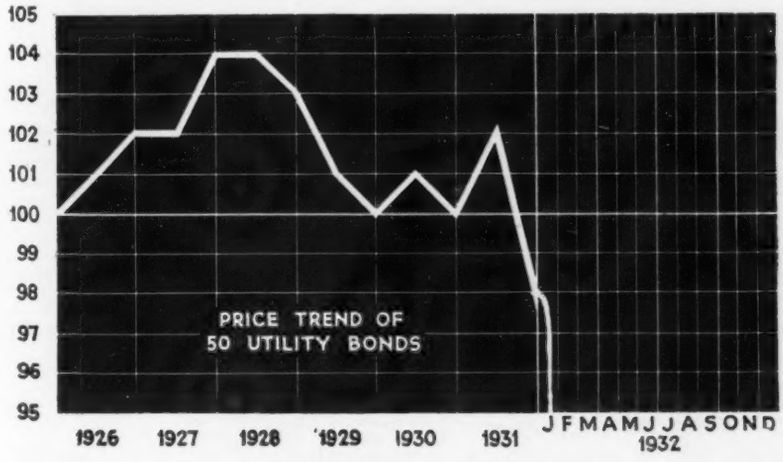
In this latter case the essence of the sinking fund plan is this: The company agrees to have on deposit with the trustee at the first of each month sufficient cash to purchase $42,000 principal amount of the bonds. This would retire the entire issue in about fifteen years, or by February 1, 1947, the nominal maturity date of the issue.

Some utilities in the past have followed the policy of establishing sinking funds to retire their funded debt over a period of years. Others make no such provision on the ground that it is unnecessary. The sinking fund, it is urged, is applicable in a business with wasting assets, or for the retirement of debt in a business in which the assets are maintained permanently. This is virtually a transfer of control from bondholders to stockholders. During the recent prosperity era utility executives and their bankers agreed that the situation was made more difficult if a company, while borrowing for expansion with one hand, were obliged to pay off debt with the other, at the same time. There are, in fact, certain unsecured obligations of utility holding companies, with maturities nearly a century in the future, where no sinking fund provision exists. A discussion of accepted practice in this regard was printed in our issue of October 3, 1931, page 621.

In many cases, of course, a sinking fund has been set up. In some cases the sinking funds are based on the amount of bonds outstanding, or a percentage of earnings, which, usually, is expected to retire a substantial portion of the bonds before maturity. Generally the deposit of funds with a trustee for sinking fund purposes, either annually or semi-annually, has been the practice. This applies more particularly to other lines of industry and business.

However, those responsible for securing this $7,500,000 loan for the Kansas Power & Light Company have instituted more rigid requirements, probably, than have ever been used in this industry. Provision for retirement of the debt has precedence over dividends and expenditure from earnings for further acquisitions.

Of course, the assumption that credit requirements in general are being tightened is not warranted from one example. Other issues marketed last week have no sinking fund provision. The $25,000,000 issue of 5 per cent mortgage bonds of the New York Edison Company was sold at 97. There is no reference to a sinking fund. The credit position of the borrowing company is still, of course, the dominant factor, but, in general, conditions of sale seem to be more rigid than formerly.



Power and light company bonds have declined sharply since the end of 1931. The average of 50 representative issues now stands at 92.1, against 97.8 at the end of December.

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Stone & Webster Complete Revaluation Plan

The plan announced by Stone & Webster, Inc., recently for a revaluation of its assets whereby approximately $77,000,000 was to be written off book values has been completed.

The plan provides for a restatement of book values in respect to, first, certain miscellaneous assets, including investments in non-subsidiary companies, to be carried at their January 1, 1932, market value or estimated fair value and which will result in a reduction of approximately $16,565,000 from present book value; second, the value of an investment in certain subsidiaries owning securities of other companies to reflect market or estimated fair value, resulting in a reduction of about $3,304,000 from present book value; third, the value of the common stock of the public utility subsidiaries, including Engineers

EDGEWATER STATION OF WISCONSIN POWER & LIGHT

Built on the lake shore south of Sheboygan, Wis., this 30,000-kw. steam station, operating at 650 lb. pressure and 800 deg. temperature, will be followed by other units as they become necessary. It is tied in to a transmission network extending as far east as Pittsburgh.

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Public Service Company and Sierra Pacific Electric Company, carried at $30 a share. This will result in a reduction of $56,839,448 from present book value.

The plan also contemplates a change in the capital and surplus of the corporation whereby capital will be reduced to $50,000,000 and paid-in surplus to about $21,500,000. This amounts to a book value of about $34 a share on the outstanding stock of the corporation.

Stone & Webster and Blodget, Inc., have filed with the Secretary of State at Albany a certificate providing for the reduction of its capital to $1,350,000 from $4,000,000.

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Illinois Unit Added More Industrial Customers in 1931

Twenty-two new industries of substantial size located during the past year in the territory served by the Public Service Company of Northern Illinois. The outstanding significance of this influx of new industries is that they will provide employment for more than 3,200 people and will have an annual payroll of nearly $5,000,000. This factor is not only of ultimate importance to the communities where most of the payroll is spent but it is most helpful in reducing present unemployment.

The new industries have in the aggregate contracted for approximately 3,239 hp. Among the more important new plants are Petrolagar Laboratories Inc., Jefferson Electric Company and Amos and Andy's Pepsodent Company.

In spite of the general retrenchment in many forms of industry during the year, the power sales department obtained but a few per cent less horsepower than was secured in the years 1929 and 1930, which were the most successful in the history of the company. The new business was diversified, as in other years, between new connected load, additions to present connected load and conversion from private generating plants on customers' premises.

The Johns-Manville Company at Waukegan, which had been served previously from a private steam-generating plant, converted approximately 12,000 hp. of load to the company's service. The steam-generating plant of the National Biscuit Company at Evanston was also shut down and approximately 600 hp. of load added to the company's system. Another sizable load, about 1,000 hp., was added at the American Steel & Wire Company, Waukegan.

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Dillon, Read Unit Gets United Light & Power Interest

One of the side issues of the American Commonwealths Power receivership is the acquisition by the United States and International Securities Corporation, a Dillon, Read investment company, of 110,000 shares of the United Light & Power Company class B voting stock. This carries with it voting control of about 10.3 per cent in the utility system.

This stock was part of the collateral in connection with a loan of $3,000,000 made to the American Commonwealths Power Corporation by the Dillon, Read Company unit. According to the agreement United States and International Securities Corporation had the right to purchase this stock at an agreed price. The largest interests are Continental Shares, Inc., and the Koppers-Mellon interest. This acquisition further complicates the control of United Light & Power, which was formerly exercised by Cyrus S. Eaton through his Continental Shares holdings.

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Financing Resumed, but Total Is Small

AGAINST total financing of $380,000,000 in January of last year, the January, 1932, total was only $32,912,500. This total, however, appears to represent a resumption of financing operations after a two- or three-month period when the flotation of new issues was virtually precluded by current quotations for existing securities and by uncertainty as to the existence of a market. Dealers were decidedly more cautious in taking their allotments on these issues, but they have reported the absorption of offerings with reasonable promptness.

Capital secured during January was evidently divided between retiring previously incurred obligations and paying for extensions and additions. A comparison of offering price is not warranted from the three widely varying issues, but it is of interest, for purposes of comparison, that series B, corresponding to the New York Edison issue sold Power, which was formerly exercised was marketed at par in 1925.

Name of Company	Amount of Issue (Par Value)	Period (Years)	Class	Purpose	Interest Rate	Price	Per Cent Yield
Kansas Power & Light Co.	$7,500,000	15	First and refunding mortgage gold bonds, series C.	Acquisition of Properties	6	91¼	6.90
Kentucky Utilities Co.	1,800,000	25	First lien gold bonds, series J	To reimburse for cost of extensions, additions and betterments and for other corporate purposes		100	
New York Edison Co.	25,000,000	20	First lien and refunding mortgage gold bonds, series C	To reimburse for expenditures on additions and improvements and to eliminate certain indebtedness		97	5.25
Total	$34,300,000			Rights			
Total amount actually realized	32,912,500			Total financing	$32,912,500		

Winter Brings Revenue Rise

Electric light and power company earnings for December were somewhat smaller than in the corresponding month of 1930. Returns thus far received by the ELECTRICAL WORLD in its monthly survey show an average decrease of 2.3 per cent for the country as a whole. If the same ratio holds for reports yet to come, the earnings of the entire industry will approximate $187,400,000, against $191,920,000 a year ago. Both figures include intercompany sales.

As usual, the December revenue shows a decided increase over that of the month before. Compared with the $180,610,000 in November of 1931 and $187,340,000 in 1930 the recent increase amounted to $6,800,000, or 3.8 per cent, while that at the end of 1930 was only 2.5 per cent.

Regional gains appear in the Southeast and on the Pacific Coast; in New England earnings were nearly the same as a year ago; in other sections there was a decrease.

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Splitdorf-Bethlehem Electrical Committee Formed

A committee has been formed to protect the interests of holders of the outstanding five-year 7 per cent convertible debentures of the Splitdorf-Bethlehem Electrical Company. Willard A. Mitchell, New York, is chairman of the committee, which includes also George A. Kinney, vice-president Chase National Bank; Wilbur Munn, president Second National Bank of Orange, N. J., and Ernest J. Howe of Blythe & Company, Inc. Part of a statement as issued follows:

"We are informed the company will be unable to meet payments of interest which come due March 1, 1932, in respect to the five-year convertible debentures. These debentures mature December 1, 1932, and it seems inevitable that they cannot be met at maturity. It therefore seems advisable that concerted action should be taken at once to protect the interests of the holders."

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Three-Way Deal in Power Exchange

A 48-year contract whereby power purchases among the companies concerned take the form of annual sums, independent of the amount of output, was signed recently between the Consolidated Gas, Electric Light & Power Company, the Safe Harbor Water Power Corporation and the Pennsylvania Water & Power Company. This was disclosed in the annual report of the last-named company.

Since annual payments of the Baltimore company to the Pennsylvania company and of the latter to the Safe Harbor company will be fixed sums, it will no longer be necessary to equalize earnings in order to eliminate the effect of variations in river flow, as heretofore. "Your company," says President Clarke of the Pennsylvania company, "under the supplemental agreement with the Consolidated company, has assumed a contingent liability to make certain annual payments or credits to the Consolidated company for the years 1932 to 1937, inclusive, with provision for possible reimbursement before the end of the period, dependent in part upon the rate of disposal by the Consolidated company of energy for railroad electrification and other purposes."

During 1930 the sum of $370,000 was drawn from equalization reserve and added to revenues of the company, because of low-water conditions in the Susquehanna River during the drought period, and $400,000 was restored to equalization reserve from surplus. In 1931 the Pennsylvania water and power report showed no amount drawn from equalization reserve, and detailed $100,000 reserved from net income for miscellaneous reserves.

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Ratify Offer to Minority Stockholders

Announcement is made that the trustees of the Consolidated Gas Company of New York have approved the terms of an offer made for minority holdings in the New York & Queens Electric Light & Power Company and decided to accept stock already deposited as the result of the efforts of the minority stockholders' committee.

The offer was left open to the few minority stockholders who have not already accepted it, with no time limit set for acceptance of the proposal. The plan provides for issuance of one preferred and one-half common share of Consolidate Gas for each Queens company preferred share, and one preferred and 2½ common shares of Consolidated for each Queens company common share. The plan is subject to the approval of the Public Service Commission. Stock so far deposited will give Consolidated Gas ownership of more than 99½ per cent of Queens company shares.

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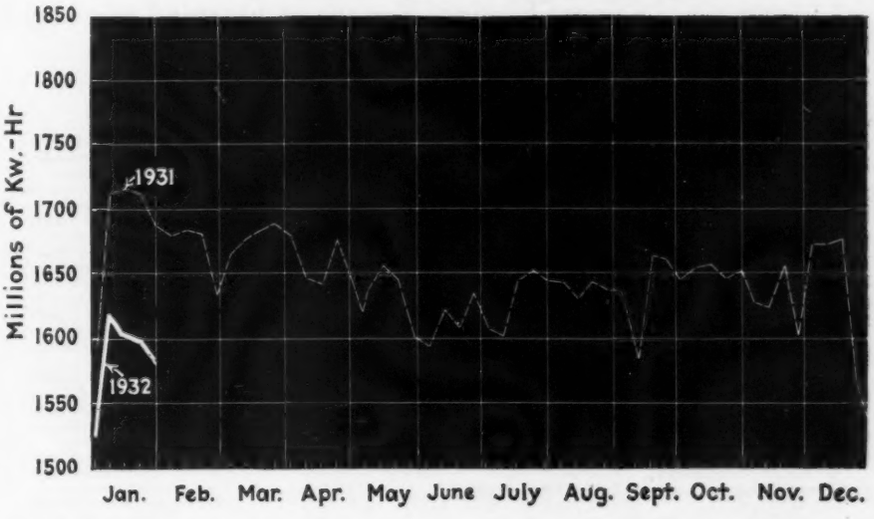
Output Falls as Days Lengthen



PRODUCTION of energy by electric light and power plants fell off a fraction of a per cent during the last week in January compared with the week ended January 23, but the decrease was less than in 1931, the National Electric Light Association reports.

Output remains 5.8 per cent below last year's for the corresponding period; a relative improvement seems to be indicated in that the two preceding weeks had shown a decrease of 6.7 per cent from 1931.

Weekly Output, Millions of Kw.-Hr.

	1932	1931	1930	1929
January 30	1,589	1,687	1,809	1,728
January 23	1,598	1,713	1,826	1,717
January 16	1,602	1,717	1,834	1,737
January 9	1,619	1,714	1,816	1,734
January 2	1,524	1,597	1,680	1,542
	(1931)	*(1930)*	*(1929)*	*(1928)*
December 26	1,565	1,617	1,638	1,527

Per Cent Change from 1931

Region	Week Ended Jan. 30	Jan. 23	Jan. 16
Atlantic seaboard	—1.9	—2.6	—2.6
New England alone	—2.6	—2.5	—2.8
Central industrial	—8.7	—9.5	—9.4
Chicago district	—5.5	—8.5	—6.4
Pacific coast	—6.5	—7.3	—7.4

High-Speed Newspaper Presses Synchronized

A most unusual and successful coordination of mechanically independent motor drives has been accomplished in the West 43d Street plant of the New York *Times*. Here an electrical tie-in system of unit drives has been installed recently which is capable of operating two double-sextuple presses at 60,000 papers per hour.

The system, said to be the first of its kind, is unusual in that the drives as well as the individual press units are mechanically independent, but are kept in synchronous speed relation by means of power Selsyn equipments incorporated in the separate motor drives. The synchronous tie-in medium employed consists of a polyphase induction-type wound-rotor motor of approximately the same capacity as the driving motor, mechanically connected thereto and arranged for chain drive to the respective press units and folders. The collector rings of the respective tie-in motors are arranged for connection in proper phase relation to a common three-phase bus. The primary windings of the tie-in elements are likewise arranged for connection to a common source of three-phase alternating-current power.

With the simultaneous application of power to the primary motor windings the respective rotors will each assume a position where the circulating current in each motor secondary is the minimum, and the rotors are thus locked in step. The respective motor rotors in such a system will maintain their co-synchronous relation as long as their primary windings remain energized and will develop a differential hold-in torque equivalent to the breakdown or pull-out torque as a normal motor of the induction type.

Slight relative mechanical displacement of this tie-in system when referred to the circumference of the printing cylinders is well within permissible limits and is smaller than that which may be normally obtained with a mechanical system of press drive involving

—*Wide World Photos*

CAUSES FANS TO LOSE THEIR HUM

Prof. W. L. Upson of the Washington University School of Engineering, St. Louis, has developed an electric fan blade so shaped as to make it noiseless, vibrationless and safe. The small blade tips strike the air at low velocity, and the air current, gaining constant acceleration, leaves the wide end of the blade in a continuous stream. In ordinary fans the blades strike the air at high velocity.

Current Earnings Reports of Electric Light and Power Companies

OPERATING COMPANIES

	1931	1930	Per Cent Increase	Operating Ratio 1931	Operating Ratio 1930
Arkansas Power & Light (Year ended November 30)					
Gross earnings	$8,235,019	$8,776,667	— 6.0	52	54
Net earnings	3,923,833	4,018,848	— 2.0	..	..
Central Arizona Light & Power (Year ended November 30)					
Gross earnings	3,175,974	3,254,268	— 2.0	56	55
Net earnings	1,382,750	1,456,380	— 5.0	..	..
Central Illinois Public Service (Year ended September 30)					
Gross earnings	14,870,648	15,406,740	— 3.5	60	58
Net earnings	5,963,904	6,468,414	— 7.8	..	..
Detroit Edison (Year ended December 31)					
Gross earnings	49,232,501	53,706,926	— 8.3	65	68
Net earnings	17,421,223	17,140,979	1.6	..	..
Florida Power & Light (Year ended November 30)					
Gross earnings	11,754,937	11,579,522	2.0	50	52
Net earnings	5,860,173	5,580,024	5.0	..	..
Idaho Power (Year ended November 30)					
Gross earnings	4,357,994	4,136,391	5.0	49	48
Net earnings	2,256,944	2,131,859	6.0	..	..
Kansas City Power & Light (Year ended December 31)					
Gross earnings	14,759,480	14,833,811	— 0.5	44	45
Net earnings	8,304,116	8,142,630	1.9	..	..
Kansas Gas & Electric (Year ended November 30)					
Gross earnings	5,671,466	5,984,631	— 5.0	50	52
Net earnings	2,864,105	2,852,114	0.0	..	..
Louisiana Power & Light (Year ended November 30)					
Gross earnings	6,207,578	6,067,145	2.0	50	52
Net earnings	3,109,976	2,890,099	8.0	..	..
Minnesota Power & Light (Year ended November 30)					
Gross earnings	6,144,211	6,476,364	— 5.0	37	39
Net earnings	3,879,510	3,968,009	— 2.0	..	..
Mississippi Power & Light (Year ended November 30)					
Gross earnings	4,995,471	5,074,957	— 2.0	62	65
Net earnings	1,868,111	1,746,865	7.0	..	..

OPERATING COMPANIES

	1931	1930	Per Cent Increase	Operating Ratio 1931	Operating Ratio 1930
Montana Power (Year ended November 30)					
Gross earnings	$8,759,739	$10,416,196	—16.0	40	39
Net earnings	5,235,146	6,355,540	—18.0	..	..
Nebraska Power (Year ended November 30)					
Gross earnings	6,823,404	6,550,173	4.0	47	49
Net earnings	3,607,548	3,338,503	8.0	..	..
New Orleans Public Service (Year ended November 30)					
Gross earnings	17,512,089	17,596,509	0.0	63	64
Net earnings	6,414,609	6,301,309	2.0	..	..
Northwestern Electric (Year ended November 30)					
Gross earnings	3,599,297	3,701,908	— 3.0	57	59
Net earnings	1,563,185	1,499,478	4.0	..	..
Pacific Power & Light (Year ended November 30)					
Gross earnings	4,686,179	4,418,495	6.0	53	50
Net earnings	2,206,280	2,180,105	1.0	..	..
Tampa Electric (Year ended December 31)					
Gross earnings	4,256,055	4,611,978	— 7.7	..	..
Net earnings	1,591,844	1,620,834	— 1.8	..	..
Texas Electric Service (Year ended November 30)					
Gross earnings	8,364,512	9,122,905	— 8.0	48	48
Net earnings	4,354,571	4,745,791	— 8.0	..	..
Texas Power & Light (Year ended November 30)					
Gross earnings	10,007,600	9,962,292	0.0	48	48
Net earnings	5,212,365	5,138,941	1.0	..	..
Utah Power & Light (Year ended November 30)					
Gross earnings	10,685,418	11,337,572	— 6.0	47	45
Net earnings	5,652,423	6,239,992	— 9.0	..	..
Washington Water Power (Year ended November 30)					
Gross earnings	8,890,865	9,472,706	— 6.0	47	44
Net earnings	4,724,999	5,313,143	—11.0	..	..

HOLDING COMPANIES

Commonwealth & Southern & Subs. (Year ended December 31)					
Gross earnings	130,116,633	141,656,531	— 8.2	46	49
Net earnings	69,705,301	72,684,117	— 4.1	..	..

backlash and torsional deflection in shafting.

The tie-in elements of this system do not develop a driving torque of themselves and therefore remain at standstill unless driven by some external means. The driving motors operate in parallel.

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Modern Automatic Control Featured at Chicago Show

A large market for motor and other electric control equipment is being opened up by the rehabilitation and rearrangement of production processes brought about by the present demand for lower costs in industry. That conclusion came from an analysis of the present industrial situation made by the Allen-Bradley Company, motor control manufacturers of Milwaukee. Believing that now is an opportune time to bring to the attention of electrical men the advantages of this company's control devices, the holding of a large exhibition covering virtually the entire field of electric control was decided upon, and Chicago was selected for this exhibit because of its strategic location as an industrial and engineering center. A large section of the fifth floor of the Engineering Building, at 205 West Wacker Drive, has been reserved for the exhibition, which will last all February.

In size and number of pieces shown this exhibition, it s believed, will set a high mark for a display of its kind. Among control equipments to be exhibited are starters and controllers for multispeed motors, automatic equipment that meets the latest requirements of power companies in the starting of large motors on network systems, and photo-electric relay apparatus.

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Copper Price Recedes Further

	Jan. 27, 1932 Cents Per Pound	Feb. 3, 1932 Cents Per Pound
Copper, electrolytic	7.25–7.50	6.50
Lead, Am. S. & R. price	3.75	3.75
Antimony	5.90	.07
Nickel, ingot	35.00	35.00
Zinc, spots	3.25	3.15
Tin, Straits	22.00	21.90
Aluminum, 99 per cent	23.30	23.30

Westinghouse 1931 Loss About $3,250,000

Last year's operations resulted in a net loss of $3,250,000 for the Westinghouse Electric & Manufacturing Company, according to a statement issued by A. W. Robertson, chairman of the board, and F. A. Merrick, president of the company. Expenses have been reduced steadily and the 1931 volume of business this year would result in a substantial profit. The $3,250,000 loss is an estimate based on eleven months' business. Current assets are stated to be twelve times current liabilities.

A sharp drop in business for November and December resulted in the final quarter showing bookings about 33 per cent under the final quarter of 1930. Bookings for January will make a much better showing, it is stated.

Drastic salary reductions, which may amount to as much as 30 per cent on salaries of over $200 a month, depending on earnings, will reduce expenses substantially, according to statements made by the executives.

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Exports of Electrical Equipment (Preliminary)

Article	December 1930	December 1931
Generators:		
Direct current—		
Under 500 kw	31,390	19,523
500 kw. and over	15,680	.....
Alternating current—		
Under 2,000 kva	11,617	6,254
2,000 kva. and over	128,817	.....
Steam turbine generator sets	566,283	11,008
Accessories and parts for generators	37,354	254,691
Arc welding sets	36,088	11,769
Self-contained lighting outfits	33,081	12,023
Batteries:		
6-volt storage batteries	125,957	81,506
Other storage batteries	198,293	38,635
No. 6 dry cell batteries	60,252	35,376
Flashlight batteries	354,969	149,031
Radio B and C batteries (dry)	49,454	26,671
Other dry and wet cell primary batteries	10,684	6,836
Transforming or converting apparatus:		
Power transformers, 500 kva. and over	90,286	272,530
Distribution transformers less than 500 kva	95,976	30,838
Instrument transformers	29,281	2,691
Other transformers	54,901	50,663
Complete battery chargers under 15 amperes	5,310	5,543
Double-current and motor generators, dynamotors, synchronous, and other converters	77,235	39,429
Transmission and distribution apparatus:		
Switchboard panels, except telephone	90,668	18,780
Power switches and circuit breakers over 10 amp.	82,487	43,675
Fuses	25,044	11,637
Watt-hour and other measuring meters	56,770	18,960
Electrical indicating instruments	44,448	26,278
Electrical recording instruments	39,551	19,621
Other electrical testing apparatus	71,967	43,532
Lightning arresters, choke coils, reactors and parts	45,902	36,248
Motors, starters, and controllers:		
Motors, ¼ hp. and under	151,354	102,320
Motors, over ¼ and under 1 hp	36,894	13,270
Stationary motors—		
1 to 200 hp	147,111	70,831
Over 200 hp	47,903	280,181
Railway motors	9,900	2,486
Electric locomotives—		
Railway	448,506	.....
Mining and industrial	130,368	21,311
Station and warehouse electric motor trucks	175	17,707
Starting and controlling equipment—		
For industrial motors	101,069	119,378
For electric railway and vehicle motors	2,115	4,022
Portable electric tools	98,699	32,719
Accessories and parts for motors	118,490	82,475
Electric refrigerators and parts:		
Household	392,821	265,712
Commercial up to 1 ton	106,671	78,106
Parts for electric refrigerators	.....	52,642
Electric appliances:		
Electric fans	92,916	14,307
Electromechanical health exercisers	5,935	1,004
Electric incandescent light bulbs—		
For automobiles, flashlights, and Christmas trees	12,636	26,223
Other metal filament bulbs	76,024	45,370
Other electric lamp bulbs	8,107	4,821
Flashlight cases	82,804	48,350
Searchlights and floodlights	25,416	13,983
Electric household washing machines	106,060	25,831
Electric domestic vacuum cleaners	124,021	82,439
Other domestic motor-driven devices, except tools	50,537	23,197
Electric flatirons	27,973	8,931
Electric cooking ranges	95,711	30,165
Other domestic heating and cooking devices	104,330	36,147
Industrial electric furnaces, ovens, and other heating devices	27,097	30,946
Therapeutic and x-ray apparatus	104,233	70,850
Signal and communication devices:		
Radio apparatus—		
Transmitting sets, tubes, and parts	120,105	53,316
Receiving sets	1,405,507	1,164,837
Radio reciving tubes	225,617	142,373
Receiving-set components	534,078	263,856
Loudspeakers	108,662	59,927
Other receiving-set accessories	162,344	49,526
Telegraph apparatus	24,129	15,614
Telephone apparatus—		
Telephone instruments	30,508	11,191
Telephone switchboards	3,863	205
Other telephone equipment	223,838	50,766
Bells, buzzers, annunciators, and alarms	26,779	173,350
Other electric apparatus:		
Spark plugs	108,733	74,935
Other starting, lighting and ignition equipment	71,673	36,252
Insulating material	69,153	23,494
Metal conduit, outlet and switch boxes	100,773	29,311
Sockets, outlets, fuse blocks and lighting switches	118,476	92,205
Electric interior lighting fixtures	154,667	66,497
Electric street lighting fixtures	35,861	29,239
Other wiring supplies and line material	106,375	52,561
Other electrical apparatus n.e.s.	648,085	364,772
Rubber and friction tape	23,047	21,405
Globes and shades for lighting fixtures	40,671	26,731
Glass electric insulators	6,222	5,908
Electrical porcelain:		
For less than 6,600 volts	29,347	17,092
For 6,600 volts and over	77,818	8,775
Carbons and electrodes:		
Electrodes for electric furnaces	110,655	134,815
Other carbon products	43,800	56,405
Insulated iron or steel wire and cable	20,836	6,734
Copper, bare wire	110,595	84,438
Insulated copper wire and cable:		
Rubber-covered wire	98,254	41,178
Weatherproof wire	16,074	10,712
Telephone cable	9,011	3,264
Other insulated copper wire	310,602	31,594
Nickel-chrome electric resistance wire	.....	22,031
Totals	$10,381,979	$6,204,781
Twelve months ended Dec. 31	$131,214,930	$92,695,345

"Payment from Profits" in Minnesota

Four suits for a permanent injunction restraining the village of Kenyon, Minn., from constructing a municipal power plant have been consolidated into one at a court hearing on petitions for restraining orders. Two of the suits were instituted by the Federal Service Company, now supplying Kenyon with power. The plaintiffs claim that the village cannot legally award contracts guaranteeing payments out of future profits. This is the issue which has been tried in half a dozen other states, with varying results.

▼

League Conference Successful

Representatives from every part of the country, including the Pacific Coast, attended the three-day conference of electrical leagues at Philadelphia on January 25-27. A profitable series of business meetings was concluded by a well-attended joint gathering with the Electric Association of Philadelphia at which President J. F. Owens of the National Electric Light Association made an address.

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Merger in Connecticut

The Connecticut Electric Service Company of Hartford, a subsidiary of the United Gas Improvement Company, has acquired the Central Connecticut Power & Light Company of East Hampton, formerly controlled by the New England Water, Light & Power Associates of Providence, R. I. The Central Connecticut serves about a dozen small communities and has a hydro-electric plant.

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Commercial Rates for Washington

Following the fixing of new domestic rates for the Potomac Electric Power Company, as reported last week (page 207), the Public Utilities Commission ordered reductions approximating 10 per cent to be made in the commercial rates. The new rates embrace a number of schedules. One, covering separately metered service used for any commercial purpose other than lighting, involves a charge of 3.9 cents per kilowatt-hour. Commercial lighting schedules begin at 3.8 cents.

▼

Regulation Plan for Kentucky

Extension of the jurisdiction of the Kentucky Railroad Commission to include supervision of light and power, telephone, gas and water companies is provided in a bill now before the State Senate. Under its terms the commission would fx the rates and pass upon the security issues of the companies, and every public utility operating in the state would pay a charge ranging from $25 to $3,000, depending upon its volume of business. Other bills provide for setting up a public utilities commission.

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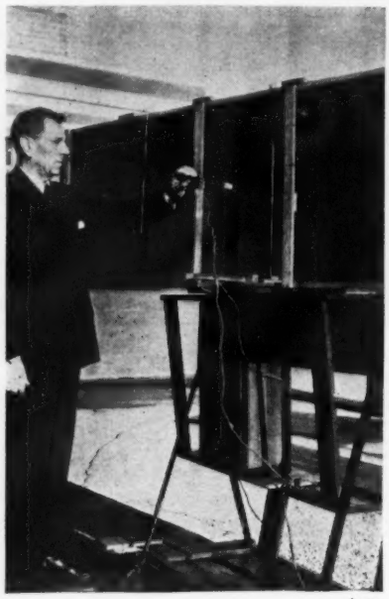
NOT A MESSAGE TO MARS



—*Acme*

Westinghouse research engineers have perfected equipment to produce ultra-short radio waves capable of being focused into a beam which by means of reflecting surfaces can be sent to record distances and may even penetrate the Heaviside layer. It is thought also to mark a long advance toward radio selectivity. I. E. Mouromtseff is here seen examining the detector detail.

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George Montefiore Prize Fund

The Association of Electrical Engineers, alumni of the Montefiore Electrotechnical Institute of Liege, Belgium, draws attention to the fact that the triennial award of the interest accruing from the 150,000 francs which constitutes the George Montefiore foundation is to be awarded this year. The sum available is 21,500 francs and is to be awarded for the original paper on scientific progress in general and the advancement in technical applications in all branches of electricity in particular which in the opinion of the judges is the best of those submitted. Competing papers may be written or printed in French or English and should reach the secretary of the foundation at the above address by April 30 next marked "Travail soumis au Concours de la Fondation George Montefiore, 1932."

Holston Plant Gets Virginia Permit

Authority has been given to the Holston River Power Company by the Virginia Corporation Commission to flood 500 acres of land on the South Fork of the Holston River at the Virginia-Tennessee line in connection with the construction of the projected hydro-electric plant at Riddle Creek, Tenn., 12 miles from the state boundary. The commission's decision was reached after several months' delay in the assumption of jurisdiction. (ELECTRICAL WORLD, June 20, 1931, page 1163.)

▼

General Rate Inquiry in Idaho

A general investigation into all power, water and telephone rates in Idaho will be made by the State Public Utilities Commission, which says that the investigation is to be undertaken because of the lower prices of other commodities in the state. Valuation hearings for the Utah Light & Power Company and the Washington Water Power Company, both of which serve certain parts of Idaho, already have been set for February, and these will be included in the general inquiry.

▼

Intercity Safety Competition

With a 1931 record of but one lost-time accident among 615 employees of the generating department (including substation operation) of the Edison Electric Illuminating Company of Boston, this group will compete with the generating department of the Duquesne Light Company, Pittsburgh, for safety honors during 1932. A trophy donated by department executives will be awarded at the end of the year. This contest was arranged by R. E. Dillon of the Boston company after reviewing the national safety figures for 1931, which showed for the Duquesne group a perfect record of no lost time due to accidents in 1,700,000 man-hours.

▼

Paris Has 3,000-R.P.M. Turbine

A steam turbine constructed to run at a speed of 3,000 r.p.m. has recently been completed by the Brown-Boveri Company of Baden, Switzerland, for the new electric power station at St. Denis, Paris, France. The machine is of 50,000 kw. rating and is designed to be operated with steam at a pressure of from 825 to 1,050 lb. and at a temperature of from 842 to 942 deg. F. In 1918 the largest 3,000-r.p.m. turbine in Europe had a capacity of only 8,000 kw., its weight being equal to 22 lb. per kilowatt as against only 16½ lb. in the case of the latest machine.

Quebec's Rate Agitation Temporarily Adjusted

Acting upon a proposal submitted by Premier Taschereau, the Quebec Legislature has solved, temporarily at least, the extraordinary problem presented by the city of Quebec's request for authority to municipalize its electrical services. The application has been rejected, certain proposals of the Quebec Power Company have been withdrawn, and the whole question of rates charged by the company in the municipal area is to be investigated by the Public Service Commission. There is to be an interval of one year during which the city and company may compose their differences. In the event of failure to reach an agreement legislative action is foreshadowed.

Before reaching this arrangement a battle royal between the municipal authorities of the city of Quebec and the Quebec Power Company was waged before the Legislature of the province.

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House-Wiring Standards Soon to Be Circulated

Both the International Association of Electrical Inspectors and the Artistic Lighting Equipment Association were for the first time represented at the second meeting of the Joint Committee on Residence Wiring Standards held in New York very recently, under the chairmanship of E. A. Brand. V. H. Tousley and J. C. Forsyth spoke for the association first named.

The committee considered item by item the first draft of the proposed standards. This will now be revised in accordance with the discussion and circulated for approval. J. H. Van Aernam, chairman of the complete home electrification committee, N.E.L.A., was invited to attend the second meeting and to present a plan for capitalizing on the work of the group. He presented a thoughtfully prepared and carefully worked out plan for a loose-leaf book for architects, builders and home owners, written in non-technical sales language and covering the three subjects of wiring, lighting and appliances.

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Southwestern Division Lighting Conference

Eleven lectures described as treating of the last word in lighting development are to be delivered at a lighting conference under the auspices of the Southwestern Geographic Division, N.E.L.A., to be held in New Orleans on February 15-18. This conference will consist, besides, of discussions by utility representatives on various lighting activities, methods of promotion and details of departmental organization. The speakers will include engineers prominent in special fields of lighting.

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Constant-Frequency Unit Exact to 0.0003 Second

A clock-controlled, constant-frequency generator has recently been developed in which extremely high accuracy of speed control is attained. This is accomplished by first running a specially wound synchronous motor from a three-phase commercial power line. The field of this synchronous motor is then electrically rotated about the motor frame by an amount which exactly compensates for the departure of the frequency of the commercial power from true 60 cycles. This rotation of the motor field is effected by a rotary synchroscope operated by thyratrons which are in turn controlled by a clock-driven 60-cycle tuning fork.

From instant to instant the motor does not maintain exact synchronism with the tuning-fork signals but always hunts slightly about the position of exact synchronism. The probable error introduced into observations by this hunting, when the generator is used as a timing device, according to the *Journal of Standards Bulletin*, has been determined experimentally to be only ±0.0003 second. Safety devices are provided which definitely guard against the possibility of this error amounting to as much as ±0.004 second. When any appreciable intervals of time are to be measured, this random error becomes negligible and the accuracy of the machine is limited only by that of the chronometer.

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Daylight Illumination for Windowless Factory

Among the many interesting innovations introduced in the design and construction of the new windowless factory of the Simonds Saw & Steel Company at Fitchburg, Mass., is the dependence upon combination lighting units consisting of mercury and incandescent lamps. More than 680 of these special units are used, each consisting of a rectangular-shaped housing and a 50-in. mercury-vapor tube in the shape of a U with four 75-watt, 30-volt incandescent lamps in a row between the parallel sides of the U tube.

Each unit takes a total load of 650 watts—300 for the lamps, 300 for the tube and 50 for the auxiliaries. This wattage produces initially about 9,000 downward lumens and the resulting light is said to approximate daylight. The units are mounted at a height of 16 ft., are spaced on 14x20-ft. centers and provide approximately 28 foot-candles on the working plane. The total load of the lighting sources in working areas of the Simonds plant is 442 kw.

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MILLIKAN LECTURES—AND HAS A FAMOUS HEARER

—*Wide World Photos*

Dr. Robert A. Millikan, who has often listened while Einstein has lectured, is on the platform this time at the California Institute of Technology, and Einstein, easily identified by his bushy head at the lower left, is listening to information on the origin of cosmic rays.

EDITORIALS

L.W.W.MORROW
Editor

Institute convention combines altruism and practicality

TECHNICAL zeal is little dampened by slumps in business enthusiasm. At least, at last week's convention of the American Institute of Electrical Engineers one was by no means conscious of a moratorium on ideas and engineering accomplishment. One was conscious, however, of the recognition of the part which technologic advance is playing in the new economic drama. President Skinner urged that the engineer play a greater rôle in promoting civic and governmental economy and efficiency. Edison Medalist Rice pointed out that education is the sole route by which our citizenry can be induced to accord the strident mechanical world the social and political accompaniments which it deserves and demands. John Fritz Medalist Pupin, in an eloquent address that set a new level for medal presentation ceremonies, placed squarely on the shoulders of our spiritual leaders the responsibility for the disjunctions in our social mechanism. Scientists like Watts, Carnot, Oersted and Faraday pried open nature's treasure chest of potentialities. Engineers in the century that has since elapsed have rebuilt civilization by means of the moving forces of heat and electricity. Twenty centuries of spiritual evolution have, however, left us so lacking in universal amity that nature's forces, capable of affording the humblest of men the affluence of the Olympian gods, are as likely to send us to the realm which Dante made vivid.

This convention stuck a dual note of altruism and practicality not equaled in many a year. While the philosophizing leaders were meditating on the consequences of technical advance, the rank and file were moving ahead in their perfection of the technique for further strides. New developments reported were almost as prolific as in the heyday of advance. The rest of the well-diversified program was devoted to calm and methodical filling of gaps in theory, to scrutinizing survey of practices that are left in abeyance when pressure of the day-by-day job focuses attention on expediencies and prompt practical solutions.

Optimism completely overshadowed pessimism in the spirit of the presentation and discussion. The engineer is not only ready to proceed—he is proceeding without hesitancy. His progress in the future is sure to embrace more collaboration with civic, economic and political agencies to assure that man's inventive genius shall contribute as much to his spiritual and social well being as to his physical comfort and economic security.

Equities as trust investments

THE oft-debated relative merits of equities as trust and insurance company investments were discussed at length at the recent joint meeting of the American Statistical Association and the American Economic Association. Certain facts brought out suggest that long-accepted economic viewpoints may sometimes be revised to advantage as basic conditions change.

An attempt to weigh the problem from an unbiased standpoint—neither affirming nor denying the suitability of stocks as investments for life insurance companies—suggests consideration of the following factors in relation one to another:

Available investments for life insurance companies and other trust institutions tend to become limited.

Equities of many stable, well-managed companies such as operating utilities have an

enviable record—one which compares very favorably with that of many holding-company obligations.

Utility capital structures have been extended, during the past decade, largely by additions to the bond and preferred stock sections of capital structures. To maintain the prescribed standards, common-stock totals could be increased substantially.

The addition of critical institutional investors to stockholder lists would be a potent factor in improving the status of stock-market trading and operations in general.

Investment departments of these institutions should be better equipped to determine the relative merits of various forms of investment than legislators of a generation or more ago.

Legal-reserve life-insurance companies have a stake of almost two billion dollars in the utilities today. Investment of but a negligible proportion of their holdings in utility equities would make a substantial difference to the market for such investments. It is at least conceivable, moreover, that the experience of other countries where common stocks are held by life companies, countries normally more conservative in investment matters, may be worth considering.

Debate should be non-commercial

ARGUMENT and debate inspire individuals to achievement. This is a major function of the professional engineering society, and the value of its programs lies largely in the introduction of topics that stimulate discussion. Last week at the convention of the American Institute of Electrical Engineers several sessions were notable for the active and vigorous discussions that followed the presentation of both theoretical and practical papers. Differences of opinion were stated and evidence was presented to support the opinions.

This was a sign of vitality. But a word of caution should be uttered about both the papers and the discussions. Many were too partisan and too commercial. Both authors and those who discuss the papers should maintain the professional status and atmosphere of the Institute. Printed papers should be fair and give credit where credit is due, and the printed bibliography, if used, should be complete and not restricted to partisan references. There was too much partisan feeling and commercial atmosphere at some of the sessions, whether premeditated or not, and this element should not be permitted to continue. The Institute is a forum for professional engineers with unwritten but definite standards that should be raised and not lowered by its members. Even in this present highly competitive age good taste and approved ethics should prevail.

Piecemeal buying harmful to buyer and seller

A MAJOR handicap to satisfactory business in the electric motor market arises from a tendency of some buyers to order a small number of units at a time when it is reasonably clear that more will be needed within a very few weeks. The point is less important in buying standard lines out of factory stock than where special features are embodied in the units ordered. It is elementary manufacturing economics to make vigorous efforts to run off volume production of units, once the plant required is set up for the particular business in hand. A good many buyers, however, fail to realize how much it is to their advantage to have manufacturing costs lowered per unit by the possibility of making clean-cut runs of specific orders all the way from foundry to shipping platform.

"Short orders" are too often being placed with the manufacturer, followed a fortnight or more later with the request that the larger-lot price be applied to the entire purchase. The manufacturer cannot meet such a demand without impairing his profit margin.

Changing the specifications after an order has been placed is also particularly troublesome in cases where motors have been designed for individual drives, especially in the many fractional horsepower applications. Changes in shaft dimensions, for instance, perhaps involving only a fraction of an inch, may completely upset the production line-up in the factory. The resetting of dies and other internal modifications forced by even minor dimensional changes in the finished product may amount to a substantial encroachment on the marginal profit from the sale of a dozen or two motors. The parties will probably

agree to cover the cost of the changes in a revised price, but at bottom the fact remains that it costs both buyer and manufacturer more to do things piecemeal.

What makes success in market development?

ACTION has been taken and the Society for Electrical Development is "done"—save for a temporary salvage operation. The effort to develop a co-ordination of the policies and activities of the four major electrical associations through a balanced representation by their leaders on the S.E.D. board is virtually abandoned. For the mere continuance of a nominal board of directors with a standby staff of three cannot accomplish anything commensurate with the need. In effect, the principles of national co-operation are officially thrown overboard by the electrical industry.

This action is at least honest. For, despite the loyal and unselfish work of an intelligent and long-suffering staff and despite the patient and persistent efforts of a group of its directors who have fought on for an ideal against infinite discouragement, organized national co-operation among electrical men has so far accomplished little. It has had negative value on various occasions in preventing strife, but its positive accomplishments have been few. Valiant efforts have been made at times to throw the combined strength of the entire industry into some concerted movement for its advancement. But the four groups have never been able to pull together.

It can be said that so far there have been but two nationally organized programs for market development that have been successfully carried out —the home-lighting and the refrigeration campaigns. Both were inspired and led by small groups of manufacturers who had the imagination to see the possibilities and the courage to spend their money. The power companies, wholesalers, contractors and dealers tied into these campaigns to take local advantage of them, and this, of course, was vital to the plan. They were cleared through the National Electric Light Association to give them a national status. But they were essentially campaigns dominated and regulated by practical self-interest—the force that builds all markets. The range campaign is being set up in the same way, which is its best promise of success.

Co-operative promotion seems to work in the electrical industry only where some strong interest grabs the ball and does the scoring. Electrical men are apparently beginning to discover that you can't build markets by talking co-operation. Arguments won't do it. Only selling sells. And in the modern marketplace selling means nothing short of advertising and making sales. There remains, however, a vast amount of educational work still to be done before there is a general public acceptance of the uses of electricity. In this all branches of the industry have a common interest, obligation and opportunity, and they should be working together in the practical co-ordination of policies and plans. It is still necessary and will have to be provided for.

Another development in mechanical rectification

THAT indefatigable and thorough worker in the field of spark-neglecting commutation, Dr. Julius Hartmann, has produced another demonstration of the rewards of persistent, studied research. Only a year or so ago Dr. Hartmann was able to announce the commercial production and satisfactory use of his mercury jet-wave commutator rectifier for street-railway service. Success had at last crowned his work of many years to produce a mechanical rectifier of alternating current utilizing as the essential medium a column of mercury which, following the natural sine-wave form of the alternating current, acted when properly commutated to supply direct current. It was a well-deserved triumph of science and skill.

Dr. Hartmann has now carried his development further and has produced the plate-jet commutator. Like the jet-wave commutator, the more recent invention exhibits an absolutely definite coupling between the voltage to be commutated and the motion effecting the commutation. It will, Dr. Hartmann anticipates, probably prove a system even more robust than the earlier one, since the exciting current and the rectified current are not passed into or tapped out of the jet through special electrodes touching the latter. It is thought that the plate-jet commutator will prove particularly well suited for the rectification of large currents at low and medium voltages.

Charles E. Skinner

President
American Institute of Electrical Engineers

"The development of the machine age cannot be stopped by declaring a holiday on research and development"

A.I.E.E. Diversifies Program

President Skinner outlines progress.
Several new devices announced.
Symposiums on time, distribution and stability.
Fair attendance and good meetings.

ENGINEERING progress never ceases on account of a depression. The midwinter convention of the A.I.E.E., held in New York January 25-29, was notable for a program of depth, scope and diversity and the attendance was in excess of expectations. In all branches of practice and in nearly all lines of equipment new contributions were made and discussions showed that engineers were keenly interested in new developments and problems. Stability of systems, protection of systems against lightning and other disturbances, the development of time services, the progress of oil circuit breakers and new developments in communication were head-line features of a well-formulated program.

A smoker on Tuesday, the presentation of the Edison and John Fritz medals on Wednesday evening to E. W. Rice and M. I. Pupin, respectively, and the dinner dance on Thursday were well received special features of the meeting and several inspection trips added to the technical values of the convention.

In accepting the Edison medal Dr. Rice urged that education is the only route by which society's appreciation of the technological foundation of our civilization can be enhanced. He urged that our legislators should know more about the technical arts and their economic consequences. Dr. Pupin in an eloquent address said that any defects of our present civilization are attributable to failure of mankind to make as much progress in twenty centuries of spiritual motivation as has been made in one century of refined application of the moving power of heat and electricity.

Skinner urges civic action

At the opening session of the convention President C. E. Skinner outlined briefly the status of the Institute and pointed out some things that called for engineering action and co-operation. He stated that the applications of electricity had been the most important factor in modern civilization and that these must go on and could not be stopped. But engineers can do much to soften the inevitable readjustments, especially those that introduced human relationships. He urged that the civic aspects of engineering be kept in mind and stated full co-operation should be given to the Engineering Council and its state branches.

A timely suggestion of Mr. Skinner was to the effect that an authoritative history of electrical developments be undertaken at once while many of the pioneers still live. Some other points made by Mr. Skinner were:

(a) Licensing of engineers is growing and interest should be taken in definitions and specifications.

(b) The new organization for making electrical standards should be supported and encouraged.

(c) The engineers have played a great part in the unemployment situation and they should co-operate and help even more fully.

(d) Instead of increased taxation there should be more economy and orderliness in government and full support should be given to the Engineering Council in its endeavor to bring this about.

At the close of his address President Skinner presented a certificate of honorary membership in the Institute to Frank J. Sprague, who received it with appropriate words of appreciation.

Pioneers receive highest engineering honors

Dr. Michael I. Pupin (seated), already an Edison medalist, received the John Fritz medal of the four engineering societies for his accomplishments as scientist, engineer, author, inventor of tuned circuits and the telephone loading coil.

Dr. Edwin Wilbur Rice, Jr., received the Edison medal for his contribution to the development of electrical systems and apparatus and his institution of the famed research laboratory of the General Electric Company.

Advocate Grounding Primary Arresters to Secondary Neutral

THAT fewer distribution transformer failures and service outages resulting therefrom would follow on the general adoption of the practice of connecting the primary lightning arrester ground to the grounded neutral of the secondary main was the impression to be taken from the "Symposium on Distribution Circuit Lightning Protection." But although this interconnection would, it was agreed, protect the distribution transformer, there arose the question then as to its effect on the premises of the customer when the neutral and lightning arrester ground resistances were high; that is, above 15 or 20 ohms. These matters were brought out in the six papers of the session and in the discussion later. Three of these papers, dealing with the experiences of as many operating companies, are presented in abstract elsewhere in this issue. Of the other three, one, by C. F. Harding and C. S. Sprague, described tests made at Purdue University on distribution transformer lightning arrester performances with impulses from a lightning generator under various conditions of connection. This paper contains the definite conclusion that:

With the usual city conditions consisting of a multiplicity of low-resistance grounds on the secondary neutral and the further possibility in some instances of a lightning arrester ground of high resistance, it has been demonstrated herein that potentials at the transformer may be greatly reduced by the interconnection of the primary lightning arrester ground and the grounded neutral of the secondary main.

In reference to this the point was raised in the discussion by Dr. M. G. Lloyd, of the electrical committee of the National Fire Protection Association, as to whether the interconnection of secondary neutral and primary arrester ground might not result in a dangerous condition on consumers' premises during lightning storms, especially in areas—as, for instance, rural districts—where it is difficult to secure a low resistance ground. Dr. Lloyd suggested that such services might be protected against high voltage rises by a secondary lightning arrester installed at the customer's service entrance.

An interesting description of field studies of lightning arrester protection, including the effects of ground and neutral interconnection, was presented in the paper by K. B. McEachron and L. Saxon. These studies were made on a single-phase, 4,600-volt rural service line of the New York State Electric & Gas Company by subjecting the line to discharges from a portable lightning generator. Cathode-ray oscillograms showed the potential differences between transformer primary, secondary and case and demonstrated that these differences were greatly decreased when the arrester ground and grounded secondary neutral were connected together. The general practice of leaving the transformer case free, electrically, from ground or other connection as a protection to linemen, which was brought out in this paper and in the following one by A. M. Opsahl, A. S. Brookes and R. N. Southgate, was commented on by H. C. Dean as not being as safe as it appears. Mr. Dean stated that the New York Edison Company had decided to ground all transformer cases because the considerable number of supposedly "free" cases had been discovered actually to be at primary potential due to bushing breakdowns from lightning. The Opsahl, Brookes and Southgate paper dealt with a series of arrester tests also made with a lightning generator and under different conditions of ground resistance and of neutral interconnection. The conclusions from these tests were:

1. Direct connection of a low-resistance primary arrester ground to a grounded secondary neutral produces no higher voltages at the customer's service than are experienced when flashover occurs with the present protection schemes.

Direct connection of a very high-resistance primary arrester ground to a grounded secondary neutral results in higher surge voltages appearing on the customer's leads than when the ground resistance is low.

2. Connection of the primary arrester ground to the secondary neutral through a low-voltage arrester gives substantially the same results as with the direct connection.

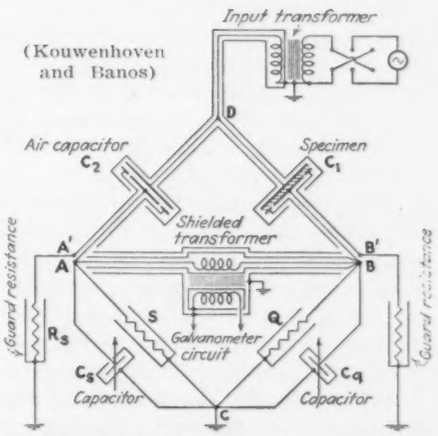
3. Connection of the primary arrester ground to the secondary outside wires through two low-voltage arresters results in increased customer voltage.

A direct result of the symposium, aside from the revision of distribution system lightning arrester practice, that will eventually follow this and succeeding discussions on the subject was the suggestion by F. W. Peek, concurred in by C. L. Fortescue, that the Institute consider the promulgation of standard lightning tests for transformers in addition to the present normal frequency test now alone required in the A.I.E.E. standards.

Graphic Meters Greatly Extended in Scope

GRAPHIC meters, or, to use the more acceptable term, "direct-acting recorders," have inescapably had less sensitivity than the corresponding indicating instruments because of the necessarily heavier weights and torques. Now, however, the application of the photo-electric principle gives the recorder a status very close to that of the indicating instruments of the highest sensitivity. C. W. La Pierre described the benefits obtained by using a light-ray pointer to actuate photo-electric tubes, the output of which is amplified to move the pen mechanism in concordance with the meter deflection.

The power for operation need not come from the measured portion of the circuit and the scope of recording meters is thus enlarged to embrace measurements not possible with



Highly shielded bridge for sensitivity in power-factor measurements

direct-acting instruments. C. W. Mayott of the Connecticut Valley Power Exchange reported satisfactory performance of a frequency meter of this type since its installation in 1930 and he also stated that it gave a frequency record that is beyond the requirements of any operating demand.

The automatic oscillograph described by Messrs. Hathaway and Buell was reported by W. G. Walker, Philadelphia Electric Company, to have recorded 63 operations on system disturbances. Of these 57 were correct in functioning. Of the six incomplete records, three were due to burned-out lamps, two to improper loading and one to failure to remove blocking after a predetermined switching operation, of which no record was desired. None were due to defects of the instrument itself. The device starts its 60-cycle record within one-half cycle; in the initial stages a mirror swings to accelerate the travel of the beam and thus compensates for the unacquired speed of the sensitized paper.

Three papers (by R. P. Siskind, by W. B. Kouwenhoven and A. Banos and by C. L. Dawes and A. F. Daniel) recorded progress in improving the accuracy and certainty of bridge measurements of capacitance and dielectric power factor. Improved shielding and advance in technique of the bridge manipulation now afford power-factor measurements as low as 0.00007. A cone type of air condenser was reported in the discussion by J. C. Balsbaugh to be capable of adjustment to 0.0001 micro-microfarad. P. A. Borden cited a scheme to make quick and accurate balancing possible by using an auxiliary frequency, say 6 cycles on a 60-cycle test, to create a long-period beat swing of the galvanometer element.

Improved Technique Aids Insulation Studies

INSULATION problems discussed in the research session on Wednesday reflected much progress in experimental technique in the evaluation of elusive quantities. A laboratory study of the interference of insulator corona on radio reception was the theme of a paper by F. O. McMillan of Oregon State College. Extended tests revealed that the corona formation voltage and the initial radio interference voltage of clean, dry insulators are identical. Standard multi-shell pin-type insulators of conventional design are susceptible to corona formation at points where the conductor and tie wire are not in intimate contact with the insulator head; at the contact between the pin or thimble and the insulating material, and between shells of multi-part insulators.

Interference may be eliminated by designing the insulator to eliminate regions of overstressed air, by using conducting flux-distributor coatings or by the use of insulating compounds. The cathode-ray oscillograph was most valuable in studying corona current. In the discussion the need of means of measuring quantitatively radio interference from this source was emphasized, and several insulator manufacturers cited the danger of cracking if the amount of porcelain used is materially increased. S. K. Waldorf, Johns Hopkins University, outlined a telephonic method of detecting the beginning of corona formation, utilizing vacuum tube amplification with the plate circuit tuned between 2,000 and 5,000 cycles and an electrode grounded through a variable resistance.

Predetermination of dielectric characteristics

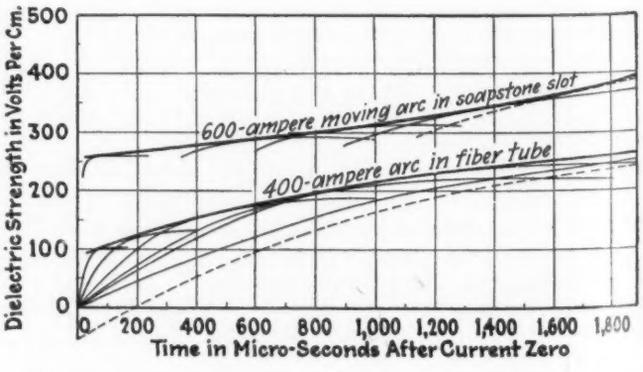
Experimental observations in a paper by J. B. Whitehead and A. Banos were cited to show that for any type of dielectric the loss, power factor and capacity at 60 cycles may be accurately predicted from the charge and discharge currents under continuous potential. The authors experimentally determined the equation for the relaxation function of the dielectric at a given temperature and maintained that the method is available at any frequency provided the continuous potential charge and discharge currents may be measured over initial time periods comparable with the alternating period. The tests covered paper, oil and impregnated paper. In commenting on the paper D. W. Roper suggested the importance of investigating the relative influence of paper and oil in studying the relation between temperature and power factor in impregnated specimens.

A research on the breakdown of glass by alternating potentials was described by N. D. Kenney, A. M. Luery and J. D. Moriarty of the Massachusetts Institute of Technology. They concluded that there are three distinct regions of breakdown and that in the disruptive and intermediate regions breakdown occurs at an alternating peak voltage approximately equal to the direct-current breakdown voltage. The breakdown in the thermal region under alternating stress is lower than with direct breakdown voltage. Since the paper was prepared the investigators have begun a similar study using rock salt instead of glass. In the discussion several speakers questioned the sepereateness of the intermediate region of breakdown.

A nomogram chart for permanent bar magnet design for maximum efficiency was presented by K. L. Scott, Western Electric Company, Inc., in a paper on "Magnetic Steels and Permanent Magnets." The author studied open-circuit remanence as affected by magnetic properties of steel, shape, dimensions and other factors. The desirability of extending research to the correlation of straight and bent magnets was emphasized. It was brought out that up to 0.5 per cent nickel is harmless in cobalt steel.

Rate of recovery of dielectric strength after arcs in fiber tube and soapstone slot

(T. E. Browne, Jr.)



Impulse Testing of Transformers Advocated in Machinery Session

PROBABLY the most constructive thing that came out of the opening session on electrical machinery was the statement by the chairman, P. L. Alger, that his committee would start forthwith on the job of specifying impulse and high-frequency tests on transformers to be set forth as Institute standards. He invites the suggestions of members in regard to the framing of these new test procedures. The proposal for such standard tests, in addition to the normal frequency checks now existing, was made originally in the session on distribution systems and lightning protection by F. W. Peek and was supported by C. L. Fortescue. Certainly such standard tests are urgently needed, if one may judge from the great diversities of interpretation of data and the forcible expressions of opinion that characterized the opening session on electrical machinery.

The papers on which the discussion centered were "Surge-Proof Transformers," H. V. Putnam, Westinghouse Electric & Manufacturing Company, and "Effect of Surge Voltages on Power Transformer Design—IV," by K. K. Palueff and J. H. Hagenguth, General Electric Company. These two papers, exhibiting philosophies of data interpretation and consequent transformer design radically different from each other and, to say the least, mutually antipathetic, enlisted eleven discussors, ten who came in two equal camps to battle with each other and the eleventh who owed—or did not announce—allegiance to either side, but smote as his conscience directed.

Two features of transformer design stated in Mr. Putman's paper are, in his words:

"1. Without the use of shields to neutralize ground capacity, it has been possible to build shell type transformers in which the distribution of surge voltages is substantially uniform, and which are practically non-oscillating even for the longest surges.

"2. A major improvement in the impulse strength of the insulation has been made through the elimination of creepage surfaces from the entire insulation structure."

These statements drew the opposing fire in shells of all calibers, ranging from references to chapters and texts to show that these features were mere resurrections of ideas dead these twenty and more years to direct contradictions of stated test results. The matter of the Palueff and Hagenguth paper is a continuation of previous studies dealing with the effects of surge voltages on power transformers, developing the conception of dangerous oscillatory currents set up in the windings by surges and presenting a quantitative theory for the calculation of these oscillations. The controversy between the proponents of these thoughts and those who minimize them in championship of graded insulation, shell type construction and elimination of creepage surfaces will no doubt, like Tennyson's brook, "go on forever," and there is little point in reporting it in detail. It is sufficient to say that a common meeting ground, such as would be afforded by standard tests, will add to the dignity of Institute discussions.

In this session a paper by A. G. Conrad and R. G. Warner disclosed the idea of a wound-rotor induction motor with both stator and rotor connected to the line. According to the authors this connection results in a practical doubling of the breakdown torque and an increase of efficiency in a motor of given rating. Among the disadvantages is the fact, noted by the authors, that a motor so connected is noisy, on account of the condition that the doubled torque is an average of values ranging from zero to four times normal. The principal point of the discussion that followed was that the same characteristics of torque and efficiency could be obtained by operating a normally connected motor at a potential $\sqrt{2}$ times the rated value.

Electrochemistry Whets Engineering Interest

EVIDENCE of a growing rapprochement of chemical, metallurgical and other engineers appeared at Thursday's session on electrochemical topics, in which market opportunities for the use of electrical energy for chemical processes were outlined by Dr. G. W. Vinal, U. S. Bureau of Standards. Dr. Vinal declared that 7,000,000 kw. in installed capacity and 36 per cent of the annual energy sales of the power industry reveal the extent of present electrochemical development. Rapid gains are being made in processes using electricity, as in the electro-wiring of zinc (purity attained 99.98 per cent), heavy-duty plating (chromium), heating and other large-scale applications. Dr. C. G. Fink, Columbia University, spoke of a trend among engineers toward chemical interests, and Dr. E. F. Northrup, Ajax Electrothermic Corporation, outlined recent advances in inductive electric furnace design leading to the attainment and maintenance of temperatures as high as 3,500 deg. C. through the use of thermatomic-carbon crucibles.

Researches in electrical precipitation by the Cottrell process featured a paper by A. W. Simon and L. C. Kron which deduced the point that the discharge current is the determining factor in performance. An interesting optical method of measuring the concentration of suspended material in smokes and mists was described. In the discussion the point was made that the sweeping of particles out of the field by corona windage may be a factor in precipitator efficiency, and that the action of the discharge current may not alone govern the effectiveness of the process.

Comprehensive studies of electrolytic condenser design and performance were embodied in two papers by F. W. Godsey, Jr., Safety Car Heating & Lighting Company, New Haven, Conn. The electromotive equilibrium theory appears to be the most promising field for the investigation of power losses. Extended data on the relation between power factor, frequency, electrolyte composition and temperature were presented, with analyses of performance in terms of film characteristics. The normal film in electrolytic condensers is an oxide or hydroxide of the anode metal which is of a greater gross thickness than the effective film. A dielectric constant approaching 80 for the effective film makes possible a reduction of former voltage gradients.

Automatic Breaker Reclosure Prognosticated

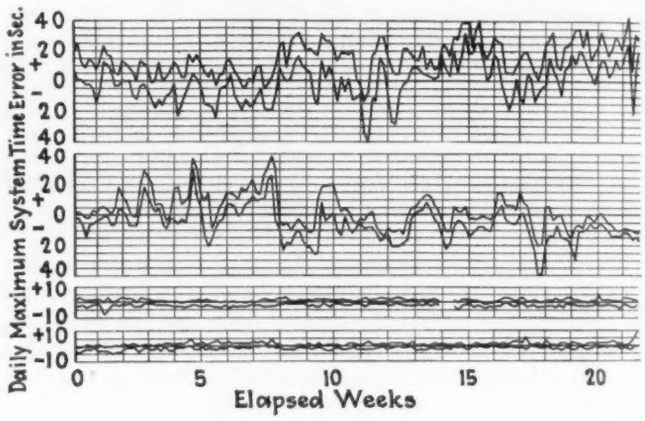
AUTOMATIC reclosure of power system circuit breakers is envisioned as a not remote outcome of the progress that has been made in increased speed of clearing line and apparatus faults. The principal deterrent at present, according to the opinion expressed by J. B. MacNeill at the symposium on stability, is the lack of full assurance about stability of the system immediately after the fault. Reinforcement of the theoretical technique of stability analysis has moved rapidly and operating studies of specific systems have multiplied, so that the fear of instability should give way to confidence and the acceptance of reduced tolerances. Trustworthy knowledge of transient stability limits holds forth real opportunity for economy in system design and operation.

R. M. Spurck commended the comprehensive report of the Philadelphia Electric Company's experience with instability on the Conowingo lines (see page 276 of this issue) as a model for operating companies to follow in subsequent studies elsewhere.

An incident of the discussion of the stability definitions and nomenclature proposed by a joint interconnection subcommittee under the chairmanship of H. K. Sels was the emphasis of the necessity for adopting a convention for the algebraic sign to be assigned to reactive kilovolt-amperes. As much confusion now exists in complex notation and vector representation of reactive components or current and power as formerly existed in connection with impedance quantities. Hardly any one today fails to assign a positive sign to inductive reactance. But C. F. Wagner found that the literature since 1910 contains 23 authorities who call lagging reactive kva. positive and sixteen who call it negative. Dr. A. E. Kennelly advocated the plus sign. Miss Edith Clarke urged that it was logical to apply to the lagging component of volt-amperes the same algebraic sign as is given to lagging component of current, in view of the general fixedness of voltage phase on the prevailing multiple system of power distribution.

How Many Millions for Time Services?

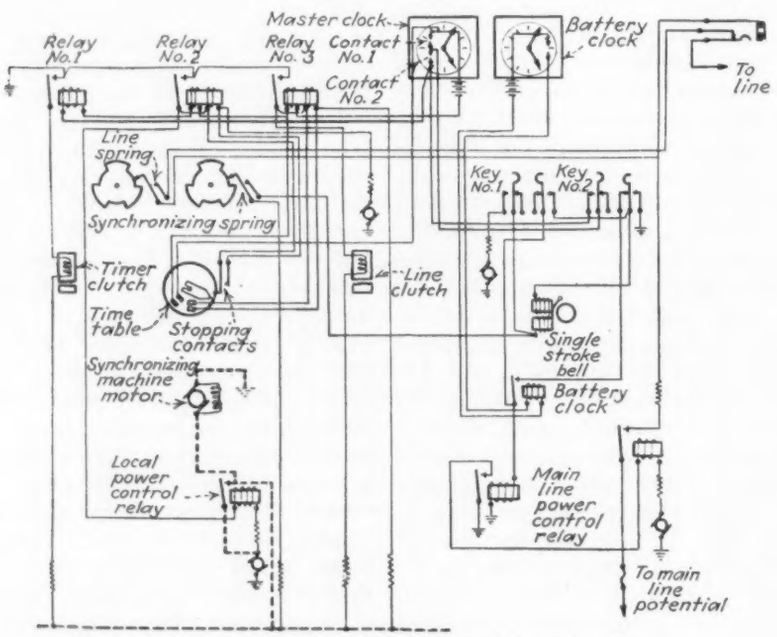
IN PRACTICAL recognition of current phobias and fetishes regarding the value of time service the Institute this year, and for the first time, devoted an entire session to the subject. Fundamental background was furnished by Professor E. W. Brown of Yale, who is likewise the retiring president of the American Astronomical Society; Captain J. F. Hellweg, superintendent of the U. S. Naval Observatory, and W. A. Morrison of Bell Telephone Laboratories, Inc. The latter described recent developments in high-accuracy 100,000-cycle oscillator quartz crystal clocks.



Maximum daily time error of four large power systems
(Warren)

In ten years, pointed out H. E. Warren of the Warren Telechron Company, the number of manufacturers of electric clocks has risen from one to eighty or ninety and today about 5,000,000 electric clocks are in use, with an energy use which yields the power companies about $4,000,000 a year, for a total equivalent in required capacity of but 10,000 kw. as a 100 per cent load factor service.

Mr. Warren discussed the relationships of time service to system operation with an apparent viewpoint which caused Philip Sporn, chief electrical engineer of the American Gas & Electric Company, to take serious issue. Mr. Sporn contended that, far from being an easy task, the regulation of system frequency for time was a difficult, complicated and possibly uneco-



Western Union clock synchronizing circuit
(Janson)

nomic problem and expressed a doubt that the advantages of supplying correct time compensated for the difficulties involved in providing it.

New High-Speed Impedance Relay

RELAYING based upon distance to faults is a new development to supplement or replace relays based upon time or overload. At the first session a new high-speed impedance relay was described by S. L. Goldsborough and W. A. Lewis. This relay is of the balanced type with a current coil and a voltage coil of the usual type and its novel feature is the addition of a voltage coil to the current coil side of the balance. This gives the relay certain features of both the reactance and impedance type of relay and makes it especially adapted to the protection of short lines. It has some limitations as to full load tripping on long lines. J. D. Neher, in discussing the paper, said it appeared to be an improved solution for selective action on faults at a distance from the supply bus, but that it has not solved the problem of a major fault near a bus. R. D. Evans said the new relay was particularly applicable to short lines and would be selective even on high-resistance, low-reactance faults. O. C. Traver questioned whether the relay would act on slow surges, although he thought it a distinct forward step in relaying. He agreed that the reactance relay should be more discriminating than the impedance relay, but said he believed the less the effect obtained from resistance characteristics the better will be the relay. He also asked about effective ground protection with the new relay and said that before the relay problem is fully solved there would have to be a reactance element and its auxiliary blocking equipment. In closing the discussion W. A. Lewis said the relay was sensitive enough to act even at 2 volts and 4 amp. in about 3 cycles and that a solid three-phase fault would be required to render it inoperative.

3-Power Locomotives, Sectional Rectifiers Attract Transportation Group

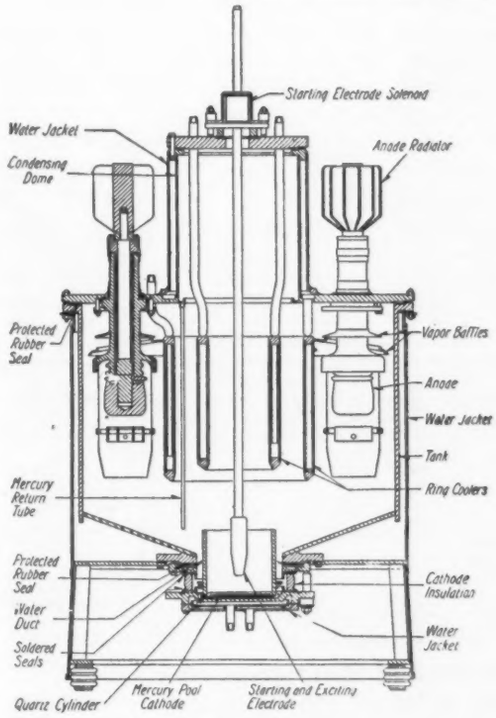
THE transportation session was devoted to a variety of subjects, of which the papers on three-power locomotives and sectional rectifiers stimulated the most discussion. Features of the Lackawanna 3,000-volt d.c. multiple-unit car motors, a method of calculating the rise of temperature of ventilated railway motors and tests preparatory to placing the Pennsylvania Railroad substations in operation were also discussed.

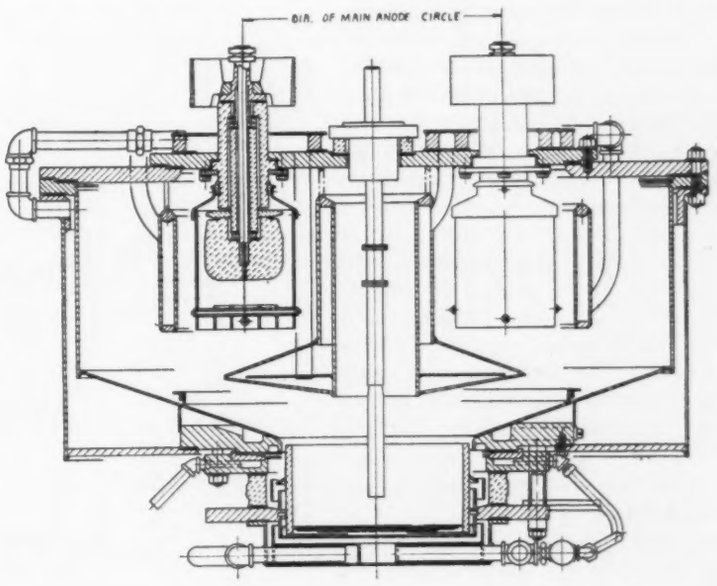
The three-power locomotives considered are adapted to operate on third rail or trolley and on an internal combustion engine supplemented by a battery. They are particularly adapted to service in congested districts where it is not practical or economical to provide a contact system but where the locomotive must also operate on a contact system to secure maximum utilization. The combination of engine and battery is most economical where the ratio of peak demand to average demand is very high. The New York Central has 36 such locomotives, the Lackawanna two and the Illinois Terminal three. Data on the performance of these units, the method of securing compact but accessible arrangements, factors affecting the selection of generator characteristics and control apparatus were presented by F. H. Brehob and F. H. Craton, General Electric Company.

A new development in rectifiers known as the sectional type was

Relative sizes and construction of conventional and sectional rectifiers

The unit at the left is rated at 500 kw. and the one at the right 750 kw. Both are designed for 600 volts. The dimensions of the conventional unit are 54 in. diameter by 104 in. over-all height; the sectional unit has a diameter of 54 in. and a height of 41¼ in., giving three times as much rating per unit volume as the conventional unit.





described and its characteristics compared with the conventional type by A. L. Atherton, Westinghouse Electric & Manufacturing Company. Its constructional features are shown in the accompanying illustration. Among the advantages claimed for it are reduced size per kilowatt of rating, increased reliability, flexibility of application and use, improvement in manufacturing requirements and an efficiency advantage of 1 per cent or more. Because of its over-all dimensions it may be grouped for multiple operation with other units in very compact formation. For example, a 3,000-kw. unit can be made of four 750-kw. units mounted side by side and two deep to occupy a space measuring only 118 wide by 68 in. deep by 113 in. high, or four units may be mounted in a single column measuring 65 in. wide by 70 in. deep by 210 in. high.

Comparing a single 3,000-kw. conventional unit with a group of four 750-kw. sectional units, the efficiency advantage of the latter at 150 per cent load is 1.25 per cent and the arc drop is 20 volts, compared with 30 volts. Arrangements can be made for taking one unit of a stack of sectional units out of service and replacing with a spare.

The 546 multi-unit car motors used by the Lackawanna Railroad have given 9,000,000 car-miles of service with only two delays of nineteen minutes and four minutes due to motor trouble. Their features, described by John C. Aydelot, General Electric Company, include provisions for withstanding interruptions of voltage and special ventilation to secure clean, dry air for cooling. Low reactance armature conductors, slot reactance proportional to load, highly responsive commutating poles and inductive field shunts are some of the features.

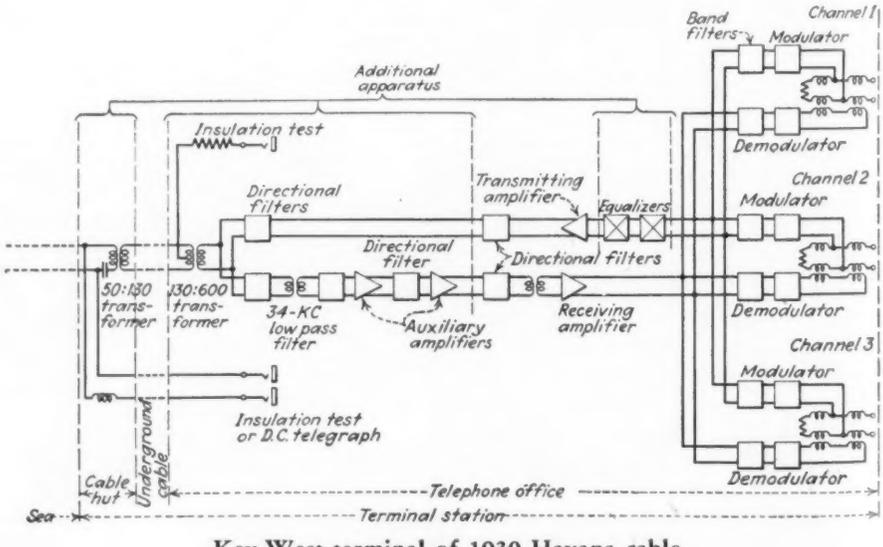
D. A. Lightband, Westinghouse Electric & Manufacturing Company, presented the derivation of formulas from which time-temperature curves of widely varying size ventilated railway motors can be plotted by substituting design data and demonstrated that the curves agree very closely with test results. The nature of tests made by the Pennsylvania Railroad before placing its new substations for the New York-Washington electrification in service was explained in considerable detail.

Discussion regarding the three-power locomotives concentrated on whether the combination of an oil engine and battery is better than two oil engines, some maintaining that the first cost, maintenance and replacement of batteries in such service is too high to warrant their use. Some of the answers given to this criticism were that the battery is needed for short periods when switching where the exhaust from the oil engine is objectionable or prohibited, that the battery is called upon only for occasional peak-load service in accelerating where there is no contact system and that the combination of engine and battery simplifies both because the engine has a mere constant load and the battery chiefly peak service. Besides the battery is smaller and does not have such a continuously heavy duty as in a straight battery drive, so the fixed and operating charges on the battery are less. Mr. Hamilton, New York Central, said the locomotives had been in use 61 per cent of the time and had been available 85 per cent of the time. Only 15 per cent of the total power used came from the batteries. He expressed the opinion that such locomotives would find wide application, especially in terminal and switching service.

Differences of opinion were expressed regarding the reliability of large and small rectifiers and Mr. Atherton's statement that there are fundamental limitations to the size of large units of the conventional type. Some speakers claimed that the multiplicity of parts in a rectifier made up of sectional units would subject it to more frequent interruptions and others pointed out that a failure of any unit would merely reduce the capacity of the bank, whereas failure of a large unit would cause outage of its entire capacity. Dr. A. W. Hull, General Electric Company, contended that no scientific investigation has proved that there is any limitation to single-unit rectifiers up to 9,000 kw. at 600 volts. Dr. Joseph Slepian, Westinghouse Electric & Manufacturing Company, said emphasis of the sectional feature had apparently made people overlook the improvement made compared with units of comparable size. When more is known about the conductivity of vapors and the cause of back-fires, some radical improvements can be made in rectifiers, which now fall far short of the ideal which might be expected from a purely scientific viewpoint.

Communication Faster and More Reliable

IN COMMON with other phases of electrical engineers' work, communication was reported to have progressed well during the past year. The new Key West-Havana carrier telephone cable represents a three-to-one saving in cable size required for comparable service, operating at frequencies up to 28,000 cycles a second, whereas the older cables had an upper limit of but 3,800 cycles. A new balance was struck between de-



Key West terminal of 1930 Havana cable
(Affel, Gorton and Chesnut)

sired attenuation and lowest possible cost.

Telegraph company practice was reported as notably improved, automatic concentration units and direct printing over long non-loaded submarine cables offering special progress in the form of increased speed.

Opinion Divided on Steam vs. Electric Auxiliaries

RELIABILITY is the outstanding requirement of power station auxiliary drives, all agreed in the symposium on the subject, but, nevertheless, differences of opinion exist regarding the fields of steam and electric drives. F. H. Hollister, Sargent & Lundy, pointed out that a power station that does not have reliable interconnections with other power stations warrants more reserve equipment and must have a greater number of steam-driven auxiliaries for starting up than one forming a part of an interconnected system. Electric drive is favored for essential auxiliaries because of convenience and cleanliness of operation and because they are more adaptable to automatic and remote control.

At present the turbine constitutes the simplest and most reliable drive for steam power station auxiliaries, said W. Poole Dryer, Stone & Webster. For applications requiring extreme protective measures, the simplicity and reliability of turbine drive may warrant its selection for all essential auxiliaries. For maximum load conditions an improvement in over-all fuel economy of the order of 2 per cent will result incidental to the use of motor drive instead of turbine drive for all essential auxiliaries; with both drives, steam would be extracted from the main turbine for feedwater heating, more being drawn where motor drive is used.

For constant-speed auxiliaries the economy due to motor drive is greater at partial loads than at maximum load. For variable-speed auxiliaries the advantage in economy with motor drive is slight at small loads.

Under most conditions the total annual expense for draft fans and perhaps for boiler feed pumps, including fuel costs, maintenance, and capital charges, will be less with turbine drive than with motor drive.

There is an element of convenience in the starting and stopping of motor drive which commends it to the average operator, other considerations being approximately equal. The use of turbine drive is not justified for non-essential auxiliaries (which may stop for a short time without inconvenience), these ordinarily being driven at constant speed.

Future developments may change the relative status of two drives, but indications are that in the immediate future progress will tend to decrease the advantage in fuel economy which the motor now possesses and to increase the turbine's advantage of reliability.

For such auxiliaries as circulating water pumps and fuel pulverizing equipment, where the output is substantially constant throughout a wide range of load on the main units, and for which constant-speed squirrel-cage motors are suitable, the electric drive maintains throughout the entire load range its relative efficiency over the turbine drive.

For auxiliaries such as boiler feed pumps and draft fans, in which the output varies with the load on the main units, the squirrel-cage motor rapidly loses advantage in the power saving which electric drive gives at maximum load; below approximately 85 per cent load on the main units it is less efficient than the turbine. At lower loads the initial relationship between the two drives can be reestablished by transferring the load to a lower speed motor, but upon reducing the load still further, this motor will, in turn, become less efficient than the single turbine.

The superior economy which the adjustable-speed wound-rotor motor gives at maximum load over turbine drive diminishes greatly as the load decreases and vanishes at small loads unless operation is transferred to an additional lower speed motor.

The chief advantages of electric drive over steam drive for station auxiliaries, declared L. W. Smith, Sargent & Lundy, are briefly:

It facilitates more efficient station design by permitting all of the steam required for feedwater heating to be taken from the main turbine by stage bleeding. It may be approximately twice as efficient in terms of B.t.u. per kilowatt-hour as steam drive, depending upon the amount of maintenance received by the auxiliary turbines. It is uniformly efficient, since lack of maintenance does not effect materially the efficiency of electrical equipment, although it may reduce the reliability of the equipment somewhat. It requires less maintenance. It is simpler to operate. It improves the physical design and operation of a station by reducing the amount of auxiliary piping required, particularly in the basement.

Some of the possible methods introduced for reducing the cost of an electrical auxiliary system are:

1. Obtain auxiliary power supply from transformers connected to the main generator leads ahead of the generator oil circuit breakers, and reserve supply from main bus if reliable interconnections are provided with

*Table I—Power Required for Electrically Driven Auxiliaries in a Modern Large Power Station**

Subdivision	Per Cent of Total Auxiliary Power	Subdivision	Per Cent of Total Auxiliary Power
Coal preparation	22.0	Station lighting	2.4
Boiler feed pumps	22.0	Coal handling	1.6
Turbine auxiliaries	22.0	Miscellaneous auxiliary power	1.5
Forced and induced draft fans	20.0	Ash sluice pumps	1.0
Heater drain pumps	3.8	Air compressor	0.7
Service pumps	2.6	Dust precipitators	0.4
Total (5.5 per cent of gross generated power)			100.0

*Table II—Investment Cost of Electric Equipment to Drive Auxiliaries of a Modern Large Station**

Subdivision	Approximate Per Cent of Total Station Cost
Prorated share of cost for portion of turbo-generator units used for auxiliary power	0.8
Auxiliary power distribution system, including transformers	1.0
Motors	1.2
Control equipment for motors	2.0
Cable and conduit for motors and control equipment	2.0
Total	7.0

*Data apply to a 200,000-kw. station using unit pulverizers and operating at 650 lb. pressure.

other stations and station bus is protected by reactors or their equivalent.

2. Establish both high- and low-voltage auxiliary power distribution groups central to location of auxiliaries instead of in electrical bay, to reduce length of cable and conduit runs.

3. Increase the horsepower range of low-voltage motors in view of relatively high cost of high voltage control equipment.

4. Diversify feeds to all duplicate auxiliaries where possible, thereby permitting simpler switching layout for adequate maintenance.

5. Use squirrel-cage motors and full-voltage starting equipment wherever possible even if at the sacrifice of a small percentage in station efficiency.

6. Use factory fabricated control equipment wherever possible.

7. Use armored cables grouped in metal troughs or large pipes for indoor and "parkway" cable for outdoor installations.

Owing to the controversial nature of the subject, some twenty engineers either requested or were requested to express their views on the relative fields of steam and electric auxiliaries, but time prevented hearing from more than seven.

Kehoe favors electric drive

A. H. Kehoe, basing comments on experience with Hell Gate, Hudson Avenue and East River stations of the New York Edison system, said: Continuity of service can be obtained with either steam or electric auxiliaries. With steam drive all essential auxiliaries are supplied by sectionalized headers fed from two sources of steam supply, and with electric drive such auxiliaries are connected to sectionalized buses fed from several sources. Flexibility of control is necessary only for coal hoist, coal feed, air and water supply to boilers; it is obtainable with either steam or electric drive, supplemented in some cases by control of the output of the driven device. For example, two- and three-speed motors are used for draft fans equipped with vane or damper control. Some difficulty is experienced in synchronizing the fuel-air ratio with combustion conditions, and fan and pump motors are liable to be overloaded if resistors different from those specified are used. Heat consumption is not so practical to measure with steam drive, but metering of energy for electric drive is simple. The net heat consumption at Hudson Avenue would have been increased ½ per cent if turbine-driven induced-draft fans had been used in place of electric drive. Some increase in investment has been experienced by using electric-drive auxiliaries, but other advantages have warranted their use. Other things being equal, it is advisable to use electric drives in place of steam to prove to customers that the industry practices what it preaches and to ascertain problems of making electric drive superior from every angle.

Remote control desirable

I. E. Moultrop, Boston, declared there is no general solution of the problem of auxiliary drives and that each case must be considered separately. He referred to the swing from steam-electric-steam and back to electric drive, and expressed the opinion that an intermediate position would be more logical as each drive has a place. Reliability is the chief requirement in driving auxiliaries, but unit cost is one of the most serious problems facing utilities. With the small water storage in modern boilers, 100 per cent reliability of boiler feed pumps is imperative. Turbine drive of boiler feed pumps is advantageous because pressure control can be used.

Valve gear needs improvement and remote control of steam auxiliaries is desirable. More compact, less expensive and more efficient control is needed for a.c. motors, particularly for stokers, fans and boiler feed pumps. Vane control of fans permits use of constant-speed motors, but Mr. Moultrop does not consider it ideal. It may become necessary to use thyratrons or some similar apparatus to permit use of d.c. motors for obtaining adjustable speeds. The complexity of a.c. motor control reduces reliability, he contended. Reactors were favored between auxiliary bus sections. Mr. Moultrop suggested that it may be necessary to swing back to turbine drives to make motor and control manufacturers expedite improvements.

H. R. Summerhayes, General Electric Company, replying to Mr. Moultrop's challenge, contended that there have been great improvements in adjustable-speed a.c. motors, but that there is possibly room for more improvement in large units. The next improvement may involve the use of d.c. motors and rectifier tubes, but they are not simple or inexpensive enough yet to apply widely.

Speaking for Francis Hodgkinson, I. E. Keating, Westinghouse Electric & Manufacturing Company, said that reliability of auxiliary drives during system disturbances cannot be overemphasized as the operating staff should not have to divert its attention from external to internal conditions at such times. He expressed the belief that the greater reliability of modern stations justifies the station bus or house generator as a feed for auxiliaries. Multiple auxiliaries are being justified by the large boiler and turbines now being used or by flexibility in operation, so reliability is increased without spending money for reliability alone. Steam bleeding makes it no longer necessary to use steam auxiliaries for heat balance, and electric drive reduces the complexity of piping and heat in the turbine room basement. Bleeding has the advantage that it permits using smaller low-pressure blading in the main turbine and smaller condensers without reducing the rating.

Huntley exclusively electric

H. M. Cushing, Buffalo General Electric Company, pointed out that even though the initial Huntley station used steam-driven auxiliaries, electric drive is now used exclusively in the latest addition. The delay in accepting electric drive has been due to designers accepting flimsy or inadequate control and equipment, failure to use drip or moisture-proof motors, and inadequate protection of busbars. He favored use of instruments to guide operators in loading auxiliaries rather than relays which might reduce reliability. It is not essential to have house alternators, he contended, but at least two sources of supply should be available to auxiliaries. Electric drive is more reliable, easier to operate and maintain and permits of centralized control, he claimed. It is not easy for operators in large plants to go around to all units, so remote control is an advantage. Dividing auxiliaries between two buses, taped busbars and increased insulation on control wires are some precautions taken to assure auxiliary reliability.

F. C. Hanker, Westinghouse Electric & Manufacturing Company, explained that the early troubles with electric auxiliaries were due to adapting industrial motors and control to conditions which demanded more

reliable service. Furthermore, electric auxiliaries were frequently purchased by mechanical engineers without consulting the electrical engineers. But there has been a great improvement, and when properly selected electric drive will give just as high reliability as steam drive. For constant-speed service the electric motor is superior, he claimed. He emphasized the fact that where stations are interconnected, auxiliary power supply can be greatly simplified without sacrificing reliability.

I. T. Baker, Consolidated Gas, Electric Light & Power Company, Baltimore, declared that reliability of auxiliary operation is not dependent on a single feature, but on a chain of factors. This fact, plus the various economic considerations, evidently causes the diversity in practice. Duplication of auxiliaries is a major contributing factor to reliability, but is not provided solely for that purpose; flexibility of operation often dictates. Although auxiliaries represent a very small portion of station investment, they should nevertheless be given major attention.

In closing the discussion, Mr. Hollister presented comparative test results to show the superior efficiency of the Rossman drive. Mr. Dryer agreed with Mr. Moultrop that electric drive has gone too far and that there should be a compromise. He expressed doubts regarding the use of thyratrons and d.c. motors because of need of reducing investment costs and increasing simplicity. Connecting auxiliary turbines between bleed points on main turbines was suggested to increase auxiliary economy.

New Electric Welders and Forces in Iron Arcs Discussed

AN a.c. arc welder was described by A. M. Candy, Westinghouse Electric & Manufacturing Company, in which high-frequency oscillations are imposed on the welding circuit to aid the initiation of the arc and prevent its tendency to snuff out each time the current passes through zero.

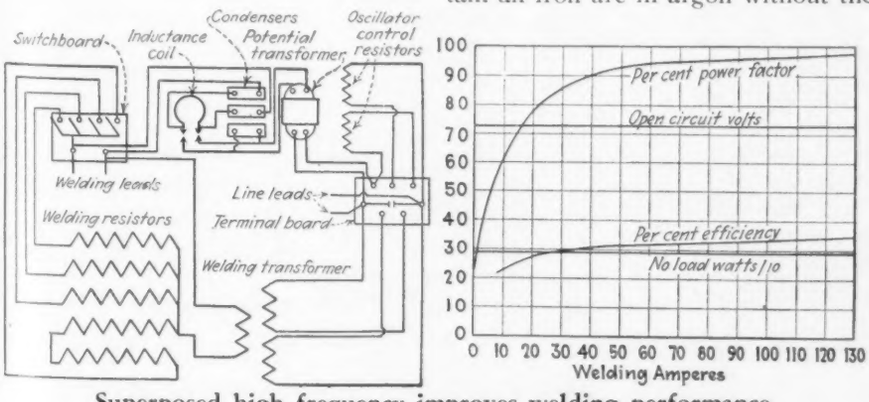
A completely self-contained arc-welding generator was described by K. L. Hansen, Milwaukee, in which the external reactor, exciter and all regulating rheostats and switches have been eliminated and the machine made more responsive to changes in external resistance.

In an attempt to explain the forces in an iron arc that transfer metal against gravity in overhead welding Prof. F. Creedy, Lehigh University, reported measurements which he has made of the forces between electrodes indicating that the force is greater than gravity with very small electrode spacings. He suggested that the "pinch effect" is the force that detaches the globules of metal and that the arc force between the electrode and globules propels them across the gap.

Most of the discussion at this session on welding concentrated on the theory of metal transference in overhead welding, there being the usual diversity of opinion on the relative value of a.c. and d.c. arc welding and which characteristics are desirable in welding machines.

The interesting fact was brought out that it is very difficult to maintain an iron arc in argon without the presence of oxides and impurities in iron electrodes, but that an arc can be maintained with lower voltage and longer arc length in argon than in air.

None of the theories can explain this action, said Dr. Joseph Slepian, who showed that thermionic emission, ionization by collision and high-potential gradient at the cathode will not account for it. However, he did say that iron oxides may be more thermionically active than pure iron, and that the boiling point of the electrode or vapor pressure may have something to do with the phenomena. Prof. C. A. Adams seemed to support the theory that the explosion of the metal globule from vapor pressure might propel it across the gap. Several persons commented on the difficulty of overhead welding without a short arc. Except for such welding, Professor Adams said that observations on a considerable scale showed that just as good or better welds can be made with the a.c. arc if coated electrodes are used. Some excellent results have been obtained with $\frac{1}{8}$-in. electrodes and 500 amp.



Superposed high frequency improves welding performance

(Candy)

New Basis for Equivalent Circuits

CONVERSION of system networks into equivalent meshes is a necessary prerequisite to their analysis on calculating boards. Mutual impedances in the original system and the appearance of negative resistances in the equivalent circuit solutions have been obstacles. The procedure explained by F. M. Starr avoids these difficulties in connection with multi-winding transformers, networks with multiple entries and several paralleled transmission lines bused at one end.

Another paper, by L. V. Bewley, in this session extended transformer theory to cover the transfer of high-frequency disturbances from the primary side to the secondary side, or vice versa. The secondary amplitudes are found to have no fixed proportionality to those in the primary and may easily rise to 50 per cent of the primary impressed wave. J. E. Clem showed that the principles enunciated in the Bewley paper will be helpful in designing insulation in transformers and connected apparatus so it will better withstand impulse phenomena in the primary.

Prompt Fault Elimination Essential for Stability

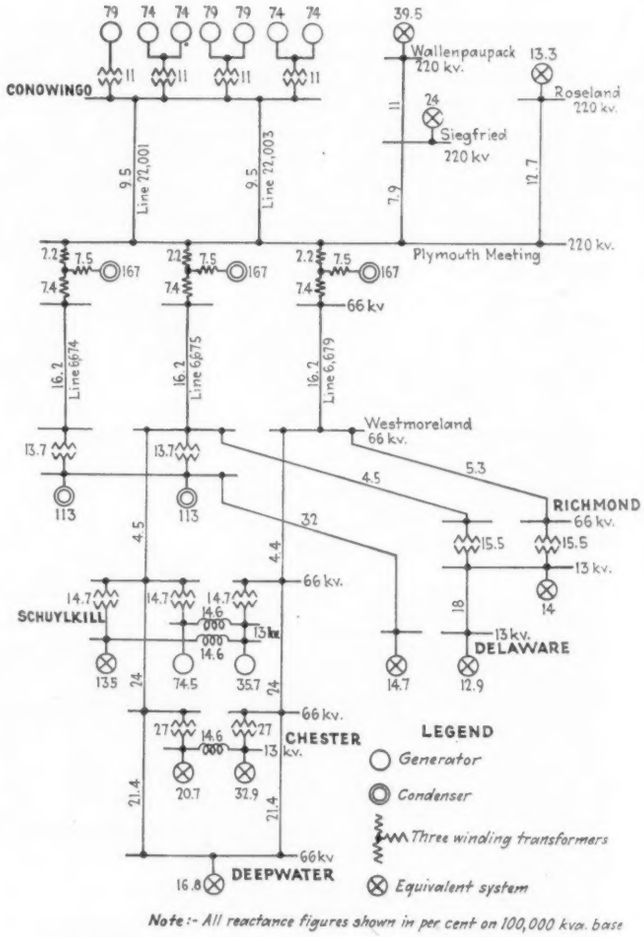
Conowingo remedies early proneness to instability under fault conditions.
Metropolitan systems have avoided instability by loose-linking and synchronizing at load.
Mathematical tools for stability analyses have been further refined and simplified.

EXTENDED transmission systems have elements inherently conducive to stable functioning under fault conditions, but in general they are less fortunate than metropolitan type systems in their freedom from interruption due to disturbances that precipitate instability when they are propagated. Urgency of the problem has apparently hastened developments which give the metropolitan system the better performance as to stability. The symposium of the A.I.E.E. session on January 27, 1932, devoted to this topic brought out three distinct advances in the technique of assuring stability with its attendant benefits to operating and investment economy.

One phase dealt with the remedial measures devised to conquer an unexpected manifestation of instability on the Conowingo system, another with the clarification of factors which have made metropolitan systems relatively immune, and a third with the perfection of the mathematical and graphical tools which have been made available for the attack upon this system problem.

Experience in operating the Conowingo plant in conjunction with the systems of the Philadelphia Electric Company, Public Service Electric & Gas Company and Pennsylvania Power & Light Company has not only thrown light on the practical causes and consequences of instability; it has been a prominent urge toward the accelerated development of high-speed excitation, high-speed relaying and circuit interruption and the fuller realization of the benefits of synchronous condensers at system intersection points. The paper[1] emanating from the Philadelphia Electric Company summarizes the lessons learned as follows:

1. Faults on parts of the system other than the main



Note:- All reactance figures shown in per cent on 100,000 kva. base

Pennsylvania-New Jersey interconnection in mileage and equivalent reactance

[1] *"Electric Stability of Conowingo Hydro-Electric Station," R. A. Hentz and J. W. Jones, paper 32-25.*

lines from the Conowingo hydro-electric station have little effect on stability.

2. Single-phase faults on the main lines from Conowingo have no very serious effect on stability, but two-phase or three-phase faults under heavy load conditions are likely to cause instability unless cleared very quickly; faults of these types are likely on the 220-kv. system.

3. Installation of high-speed relays and circuit breakers on the high-voltage system has insured the rapid clearing of faults, thereby practically eliminating the danger of instability, except possibly for three-phase faults.

4. System stability may be calculated with sufficient accuracy for all practical purposes and such studies are essential for the design of the system.

5. Much credit is due the manufacturers for development of practical methods of studying stability and also for the production of remedial equipment.

6. Short-circuit tests on the system and special tests of such equipment as high-speed excitation give results which fully justify the expense incurred.

7. Permanently installed automatic oscillographs are desirable (1) to investigate and analyze conditions which lead to instability, (2) to check calculations of stability limits and (3) to check the operation of relays.

Single-phase fault assumption not justified

Before the 220-kv. lines of the Conowingo system were built extensive studies and calculations were made to determine stability limits in connection with line faults. Information available at that time apparently justified the assumption that faults could safely be assumed to involve only a single phase. Later experience revealed the weakness of that assumption. But having made the assumption, the calculations indicated that there might be some swinging under certain fault conditions, but that synchronism could nevertheless be maintained. To attain this result two types of measures were taken in the initial design of the station and lines. Preventive measures included heavy insulation and double ground wires for lightning protection, shielding for substation structures and lightning arresters at appropriate points. Remedial measures to clear faults and stiffen the resistance to instability involved a special relay system in conjunction with the fastest (less than one-half second) breakers then available for 220-kv. use. Generators were built with as low transient reactance as possible consistent with reasonable cost and efficiency in such slow-speed machines. The three-winding transformers at Plymouth Meeting substation were designed to give close coupling of the synchronous condensers to the 220-kv. system.

One 30,000-kva. condenser is provided for each of the three transformers, and in case of a system disturbance, their exciter voltage is automatically increased at the rate of over 6,000 volts per second. Meanwhile, the loading rises from normal value of 10,000 kva. to 58,000 kva. in one-half second. Westmoreland also has condensers with automatic high-speed excitation. The 60-cycle motors of several frequency converters on the Philadelphia Electric system are used as condensers. They and all generators on that system have automatic voltage regulators. The Conowingo generators have special high-speed excitation designed to prevent a drop of more than 2 per cent in induced voltage when full-load lagging reactive kva. is suddenly applied while the generators are carrying full rated load at unity power factor.

During the first year, 1928, three faults occurred on the Plymouth Meeting-Conowingo lines and each involved two phases instead of the one anticipated. Conowingo became unstable. In the first instance lightning on the line tripped both lines at Conowingo and all five generators (carrying 168,000 kw.) tripped on overvoltage or overspeed. In another instance a fire from foreign causes burned down two 66-kv. conductors and made a two- or three-phase short on the Chester-Schuylkill line. Four out of six machines at Conowingo were tripped out, dropping load from 218,000 to 26,000 kw.; Philadelphia had to drop 30,000 of its existing 297,000 kw. In the second 220-kv. case, lightning on July 4, 1928, caused a two-phase flashover 5 miles from Conowingo at a time when five generators were carrying 112,000 kv. of holiday load. One was tripped on overspeed and the others were out of step with the system for six seconds until the opening of the unfaulted Plymouth Meeting line detached them. Again lightning about 4 miles from Plymouth Meeting caused a two-phase flashover on the line while four Conowingo generators were carrying 140,000 kw. The faulty line tripped at both ends with an estimated clearing time of 0.3 second at Plymouth meeting and 1.7 seconds at Conowingo. All four operating generators tripped on overspeed; the Hall recorder showed loss of synchronism in less than one-half second. None of the 300,000 kw. of Philadelphia load was dropped. Low setting of relays appears to have been the cause of still another case of instability.

Prompt emergency methods applied

Naturally such untoward happenings gave alarm and the study which was promptly instituted disclosed that lack of records giving the time of occurrence and sequence of events at faults and in the stations would retard a quick removal of the difficulties. Pending the extensive installation of multi-element oscillographs and recorders, certain temporary measures were adopted at once. Storm reporting was intensified and the 220-kv. system was split during storms if more than four generators were in operation; this procedure was followed until 1931. Meanwhile special tests were undertaken to ferret out the sources of weakness at points where previous information was inconclusive. Observers were spread over the system to take records of intentional single-phase and two-phase faults. All lines and synchronous equipment were in service, but without load. Twenty-nine oscillograph elements were used to measure a much larger number of significant quantities.

These tests proved the satisfactory functioning of the relays except that over-all time of circuit interruption was longer than desired. Conowingo generators did not swing against one another, nor was there any governor hunting. The faults were apparently of low impedance and the arcs did not blow from one conductor to another. High-speed excitation was found to be falling short of expectations.

Another test made under load showed that the speed increased so rapidly that some of the units advanced 180 deg. ahead of the system in less than 0.3 second after opening their switches. This naturally explained how the plant got out of synchronism so quickly when electrical output was seriously reduced because a fault pulled the voltage down. Other tests showed that short-circuit current calculations were substantiated and that there

Instability Experience with Faults on Plymouth Meeting-Conowingo Line

Year	1928			1929				1930				1931			
Date	June 9	July 4	Aug. 17	June 14	June 15	July 29	Aug. 21	Jan. 14	June 26	July 6	July 21	May 10	July 9	July 9	July 24
Time	5:27 P.M.	4:12 P.M.	3:06 P.M.	11:48 P.M.	1:21 A.M.	4:12 P.M.	5:06 A.M.	12:31 P.M.	7:48 P.M.	7:19 P.M.	7:14 P.M.	8:52 P.M.	7:41 P.M.	9:01 P.M.	1:47 A.M.
Line No.	22,003	22,003	22,001	22,001	22,001	22,003	22,003	22,003	22,003	22,001	22,003	22,003	22,001	22,001	22,003
Cause	Lighting						.....	Lighting			Switch Failure	Lighting			
No. phases	2	2	2	1	1	2	1	1	1	1	1	2	1	3	1
Miles from Plymouth Mtg.	2	53	4	..	..	..	..	17	28	..	0	18	5	22	33
Residual current (Conowingo)	..	..	..	Open	Open	..	Open	915	500	420	450	1,370	940	..	Open
Residual current (Plymouth)	..	..	..	1,300	1,350	..	..	..	700	3,000	..	2,600	4,500	..	2,600
Positive sequence voltage (Plymouth)	..	..	..	..	..	..	..	..	115	87	98	76	95	..	115
Clearing time (Conowingo)	..	10	102	Open	Open	69	Open	45	107	71	37	11	12	Est. 40-50	Open
Clearing time (Plymouth)	..	62	20	18	16	20	35	31	35	33	55	8	15	Est. 40-50	8
Load Conowingo, megawatts	168	112	140	30	0	66	0	263	170	92	150	235	145	165	35
Load Philadelphia electric steam generation, megawatts	34	46	220	225	211	349	226	159	258	145	323	89	248	241	163
Load Philadelphia electric system, megawatts	202	158	360	252	207	423	250	392	390	223	473	329	345	396	207
220-system set-up	Solid	Solid	Solid	Solid	Solid	Solid	Solid	Solid	Split	Solid	Solid	Solid	Solid	Solid	Solid
Conowingo stability	Unstable	Unstable	Unstable	OK	OFF	OK	OFF	OK	OK	OK	OK	OK	OK	Unstable	OK
Conowingo power swings, megawatts	..	..	..	..	..	..	..	200 325 Est.)	75–100	70–100	130–155	164–292	114–185	313–313	31–8

was slight error in the assumed value of zero sequence reactance of the Conowingo lines.

New calculations were based on the assumption of two-phase faults. They showed that stability could not be expected with solid bus operation of the 220-kv. system unless a fault near the end of the line was cleared in about 0.15 second. High-speed switching was also indicated as the solution for instability arising out of two-phase faults on the Plymouth Meeting-Westmoreland line. Development of high-speed breakers and relays took place at once. Reports of the tests on this new equipment appeared in ELECTRICAL WORLD on October 12, 1929 (page 735), April 26, 1930 (page 844).

Permanent measures decided upon

The studies and tests lead to the adoption of the following permanent measures for improvement:

1. New high-speed circuit breakers were purchased and arrangements made at Plymouth Meeting and Westmoreland so that high-speed breakers were provided for normal operation on all 220-kv. and 66-kv. aerial lines.
2. The 220-kv. line breakers at Conowingo were rebuilt so that high-speed operation was obtained.
3. The relay system was revised and new high-speed relays installed on all lines to reduce the operating time to about one cycle.
4. A third step-down transformer was installed at Plymouth Meeting.
5. A third 66-kv. line was added between Plymouth Meeting and Westmoreland.
6. The 66-kv. system was split into three separate sections at Plymouth Meeting and Westmoreland.
7. The 220-kv. line insulation was increased from fourteen to sixteen units for suspension insulators and from sixteen to eighteen units for strain insulators.

Since that first year, when four cases of instability occurred, there has been, as will be seen from the table presenting the four-year summary for the Plymouth Meeting-Conowingo lines, only one case of instability. In this table the residual current is shown in amperes as measured in the faulted line. The positive sequence voltage is expressed in kilovolts equivalent line to neutral on the 220-kv. system measured at Plymouth Meeting during the fault. To determine the magnitude of the shock to the system these values should be compared with the normal value of 127 kv. Clearing time is given in cycles. Power swing figures for Conowingo are the first maximum and minimum value of average power output for the surges following the clearing of the fault.

At the time of the severe disturbance on July 9, 1931, the plant was carrying 165,000 kv. when a three-phase lightning flashover occurred 22 miles from Plymouth Meeting. It took almost a second to clear the fault because there was practically no ground current and the only high-speed relays in service were the ground relays. The experience prompted the adoption of high-speed balanced protection. But at the time the relatively small ground current did not suffice to start the automatic oscillographs and consequently no definite record of the clearing time was obtained.

Faults on the other interconnected lines seem all to have been of single-phase character and did not result in Conowingo instability. Likewise has synchronism been maintained through the single-phase faults that have occurred in transformer windings. While faults on the 66-kv. lines from Plymouth Meeting to Westmoreland are serious because they carry most of the Conowingo output, synchronism has been maintained through all that have occurred. Even a three-phase fault at Siegfried while Conowingo was carrying full load, and which lasted about 52 cycles, did not cause trip-out from the swings which followed. Positive sequence voltage at Plymouth Meeting dropped to 60 per cent of normal and the swinging after the disturbance was about 174 to 334 megawatts.

Faults on the 66-kv. Philadelphia Electric system are largely single phase because the underground cables are single-conductor; even though these faults sometimes last more than one second they seldom occasion instability. A system of pilot wire protection is being installed to reduce the clearing time for cable faults.

That no stability problem exists in the case of the metropolitan systems is an assumption not warranted

merely because they currently reflect an excellent operating record from the standpoint of stability. Analysis is desirable because pressure for reliability and lack of knowledge about the transient stability limits may in some cases have led to undue liberality in design. One of the papers[2] asserted that greater stability may have been provided than is necessary or else the same degree of stability could have been obtained at lesser cost. Stability must share its importance with reliability of power sources, flexibility of operation and minimization of interrupting duties when the evaluation of the optimum system layout is made.

Analysis of the metropolitan type systems is facilitated because they have many points in common with one another and consequently generalized curves may be set up with the hope of broad applicability. Another point is that static instability is never experienced in the normal operation of metropolitan type systems in which steam turbines predominate in supplying nearby load centers over a large number of moderate voltage circuits. The methods of analysis proposed by Messrs. Griscom, Lewis and Ellis are believed by them to be adequate for cases where remote hydro sources are present but do not constitute more than one-fourth the total generating capacity of the system.

The features of similarity between such city systems reside in the following:

1. With equal per cent loadings the internal voltages of all generators on the system are practically in phase.

2. Because of the multiplicity of circuits the reactance of the connecting ties holding a generator or group of generators in step with the system does not change appreciably when the fault is cleared.

3. With steam-turbine-driven generators and short transmission distances the generator characteristics, no longer being affected by speed of the prime mover, line-charging current requirements, etc., tend to become fairly uniform in their essential point, e.g., reactance, inertia and short-circuit radio.

This degree of similitude makes it possible to calculate the stability of a number of hypothetical system layouts and plot the results of these calculations in the form of curves. The remaining variable factors are used as indices. With a given system layout the measure of stability under fault conditions is the permissible duration of the fault. The curves offered therefore give the results in seconds of permissible fault duration. The most important factors affecting the duration are the initial generator output, the synchronizing power and the severity of the fault.

Curves devised have broad applicability

The fundamental premise underlying the use of generalized curves for stability determinations is that set-ups giving the same values of the essential indices will have approximately the same degree of stability. The problem becomes one of determining the indices from the actual system set-up and then obtaining the permissible fault duration of the corresponding hypothetical system set-up from the general curves. The indices can be obtained from three readings on a d.c. calculating board.

Concentration of large amounts of generating capacity on a single bus to meet the larger metropolitan loads has accentuated the magnitudes of short-circuit capacity and greatly increased the danger of system outage from the effects of a single short circuit. Synchronizing at the load and loose-linking have been evolved to meet this situation and also the use of synchronizing buses to connect individual generators through synchronizing reactors. The synchronized-at-the-load scheme, if carried to the limit, would result in a star connection and this is easy to calculate. Also, for the same over-all reactance, experience and calculations both indicate that it would be the least stable. Consequently any error introduced would be on the side of safety because the permissible fault duration computed would be less than that which could actually be permitted.

Other papers in this group presented definitions[3] for the terminology which arises with the art of stability analysis, the redetermination[4] and extension[5] of the decrement curves for use in connection with short-circuit behavior and relay settings and a new "internal voltage" method[6] of determining variation of short-circuit current in systems not reducible to a single equivalent generator.

[2] *"Generalized Stability Solution for Metropolitan Type Systems," S. B. Griscom, W. A. Lewis, W. R. Ellis, paper 32-26.*

[3] *"Proposed Definitions of Terms Used in Power System Studies," H. K. Sels.*

[4] *"Standard Decrement Curves," W. C. Hahn and C. F. Wagner.*

[5] *"Decrement Curves for Specific Systems," W. C. Hahn.*

[6] *"Calculation of Short Circuits on Power Systems," C. F. Wagner and S. H. Wright.*

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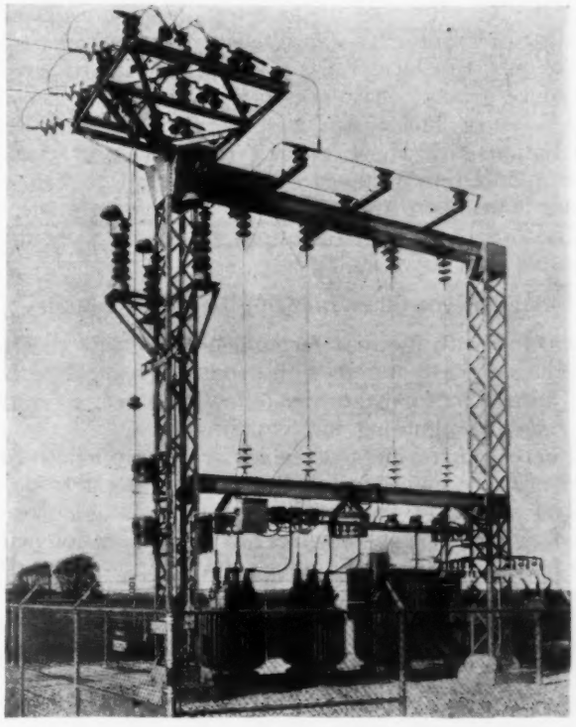
Single-Bent Substation



By adding to one column a frame on which disconnecting switches are mounted and setting on the same column brackets for lightning arresters, the engineers of the Detroit Edison Company have devised a single-bent substation that is quickly and economically erected for industrial and small municipal service. The substation pictured here contains three 500-kva, transformers serving a water pumping station.

Lightning Troubles on Distribution Systems

ON OVERHEAD distribution transformers of sizes above 15 or 20 kva. arresters are of value in the reduction of service interruptions from lightning. Spacing of transformer internal connections is an important factor. This is apparent from the evidence of greater trouble with older transformers equipped with terminal boards and/or having small clearances between leads inside the case. The types of bushing used on transformers built more than fifteen or twenty years ago contribute largely to the severity of lightning troubles on these units. These and other evidences that appear to make a conclusive case for the lightning arrester as applied particularly to the larger sizes of distribution transformers are derived from experiences in Chicago, Philadelphia and Boston.*

The five-year experience covered by the Boston paper shows that the trouble rate of protected transformers has consistently been materially less than the rate of those not protected, notwithstanding the high normal ground resistance of New England soil. It shows al that the effectiveness of arresters is practically independent of ground resistance when resistances are above 100 ohms. In Chicago it is concluded that extra expense to reduce ground resistances below 50 ohms is not warranted. In Philadelphia a short experience with 345 installations, of whose ground resistances 45 per cent were reduced to below 15 ohms, and all to below 50 ohms, indicates a substantial reduction of trouble, but the history of these installations is not long enough to permit a conclusive statement.

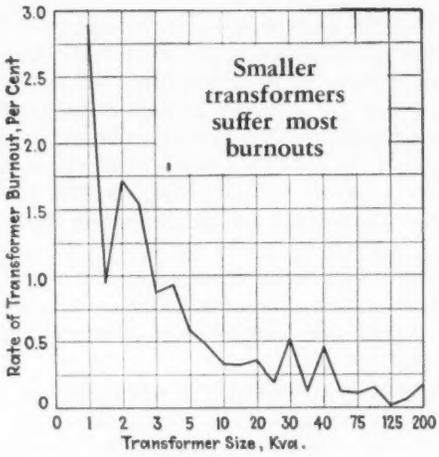
Suggestions for minimizing lightning troubles

Starting with the first recommendation, that the four-wire, three-phase system with grounded neutral be used, the Chicago paper makes the following other suggestions for reducing lightning interruptions:

Where transformers or cables are connected to overhead primary mains install low-voltage arresters on the neutral wire and valve type arresters suitable for the Y voltage on the phase wires; avoid duplication within 500 ft. and reduce the number, for Chicago conditions, by one-third.

Use transformers having insulation on the coils and leads that will not deteriorate with age and which will withstand a transient voltage test safely above the voltages to which the transformer will be subjected in service when protected by the arresters.

If conditions warrant a second ground rod for reducing the resistance of the lightning arrester ground



install also a second ground wire down the pole and connect it to the second ground rod.

Select newest transformers for installation in districts of low arrester density and install the older transformers in high density areas.

Require each customer to ground the neutral wire of his house wiring to a water pipe on his premises.

Connect the neutral wire of each section of secondary mains to at least two ground rods; on long mains install ground rod connections at intervals not exceeding 600 ft.

Interconnect, to a reasonable extent, the neutral wires of adjacent secondary mains.

Interconnect the lightning arrester ground wire and the secondary neutral wire when the latter is well grounded.

Where transformers are connected to primary mains 1,500 ft. or more distant from the nearest transformers install on the pole about 600 ft. from the transformers the same lightning arrester equipment as on the transformer pole.

Ground the lead sheaths of all underground primary cables.

By following these suggestions and giving the subject continuous engineering supervision, it appears possible to reduce the number of transformer troubles in Chicago caused by lightning; that is, fuses blown plus transformers burned out, to less than one case of trouble per year per one thousand transformers installed.

Experience in Philadelphia allows these definite conclusions to be drawn:

Annually about 5 per cent of the 23,000 aërial distribution transformers experienced lightning trouble. The small transformers have been found more susceptible than large ones. As far as practicable, the larger transformers should be used, or the older units replaced with more recent ones of the same size.

Difference in susceptibility between transformers of

Symposium, A.I.E.E. winter convention, January 25-29, 1932, on "Distribution Sytem Lightning Studies." Papers by D. W. Roper, Commonwealth Edison Company; H. A. Dambley, H. N. Ekval and Howard S. Phelps, Philadelphia Electric Company; T. H. Haines and C. A. Corney, Edison Electric Illuminating Company of Boston.

Summary of Lightning Experience in Protected Area of Boston System

Year	No. of Weather Bureau Lightning Observations	Per Cent Protection	Av. Grd. Res.	Trans. with L.A.'s: No. of Trans.	Trans. with L.A.'s: Troubles /100 Trans.	Trans. with L.A.'s: Troubles /100 Trans. /100 W.B.O.	Trans. without L.A.'s: No. of Trans.	Trans. without L.A.'s: Troubles /100 Trans.	Trans. without L.A.'s: Troubles /100 Trans. /100 W.B.O.	All Transformers: No. of Trans.	All Transformers: Troubles in Year	All Transformers: Troubles /100 Trans.	All Transformers: Troubles /100 Trans. /100 W.B.O.*
1927	144	34	201	1,484	25.5	17.7	2,836	44.4	30.8	4,320	1,637	37.9	26.3
1928	82	38	210	1,805	9.9	12.1	2,970	13.9	17.0	4,775	600	12.6	15.4
1929	126	49	196	2,407	12.1	9.6	2,487	38.0	30.2	4,894	1,239	25.3	20.1
1930	118	56	214	2,930	15.7	13.3	2,329	22.6	19.2	5,259	987	18.8	15.9
1931	114	71	234	3,781	4.2	3.7	1,562	7.6	6.7	5,343	278	5.2	4.6

* This column represents an attempt to express occurrences of trouble in terms unrelated to the extent of protection on the system.

different sizes must be recognized when analyzing arrester performance. Observations over five years show little benefit from arresters when considering transformers of all sizes collectively. However, taking size into account, these same data indicate arresters afforded little benefit to those of 15 kva. and less, and substantial benefit to the larger sizes.

Because of the many factors involved, it has not been possible thus far to determine whether there is material difference in susceptibilitiy to lightning trouble on grounded and ungrounded systems.

Low ground resistance, which theoretical and field studies show to be essential to effective arrester performance, may be obtained at low cost by connecting the arrester ground wire to the secondary circuit grounded neutral where a well-grounded secondary neutral grid exists. Limited field experience shows this method to furnish satisfactory protection against transformer failure without introducing additional secondary troubles.

Customer interruptions from trouble on the primary system far exceed those from trouble on the secondary system. Therefore, major improvement in service continuity can best be accomplished by attacking the primary situation. However, service reliability as measured by the customer is independent of the source of trouble, and consequently improvements on the secondary system cannot be neglected.

The major number of customer-hour interruptions due to all causes occur during electrical storms. Of these, it is estimated that one-half are directly attributable to lightning disturbances.

In the interest of improving service continuity, lightning protection of distribution systems has been found to be of major importance. Also, it is significant that it can be justified economically only from this point of view. The important factor is the inconvenience to customers which may thus be minimized. Although intangible, this factor is nevertheless very real and should be carefully considered in establishing policies and practices in meeting the problem.

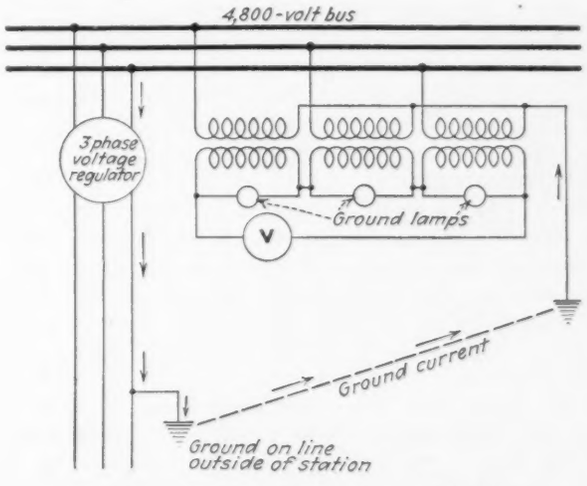
And in Boston the experience has been that the application of lightning arresters to line transformers in areas affected by lightning reduces the trouble rate by about 50 per cent. Variation in ground resistance within the values readily obtainable in the territory has slight effect on the efficiency of the arrester. The value of treating grounds or the installation of multiple grounds in an effort to lower resistance is questionable unless by so doing the resistance can be decreased to a value approximately 100 ohms or less. Insufficient electrical clearances in the smaller and older transformers are an important source of lightning trouble. Larger bushings and greater clearances are clearly indicated as a necessary feature of correct transformer design.

Which Line Is Grounded?

By L. M. SCHAFBUCH and L. WORKS
Substation Department,
Detroit Edison Company, Detroit, Mich.

Ground detectors in distribution substations perform the function stated by their name, but they do not tell where the ground is. It may be on any one of the lines connected to the bus. One way to find out is to operate the relay on the faulty line by the momentary connection of a grounding transformer to the bus. Another way requires a bus system which permits transferring lines from one bus to another without interrupting service. The line whose transfer from one bus to the other also moves the ground indication to the second bus is the one that is in trouble. A third way is to open the lines one at a time and observe which line interruption causes the ground indication to disappear. This third method is the one commonly used in small, unattended substations because the two other ways do not justify their expense.

A fourth method has been devised by the writers and is in use on the system of the Detroit Edison Company.



Combined ground detector and locater

It is applicable to any line equipped with an induction regulator, as most circuit feeders are. A voltmeter is connected in series with the delta-connected ground detector transformer secondaries, while the voltages on the lines are changed one at a time by means of the induction regulators. The grounded line will be indicated by a change in the reading of the voltmeter when the regulator on that particular line is operating.

Oil Breaker Theory Debated

Turbulent gas vs. oil-blast principles.
Test data on modern breakers.
Discussion active and positive at A. I. E. E. session.

OIL circuit breakers have two aspects today. One is the fact that they have been vastly improved so that their speed, their capacity and their reliability are beyond the expectations of experts of even five years ago. The other lies in the realm of theory. One major school of thought asserts that arc extinction is a deïonization phenomena whereby arc gases are useful and necessary and whereby the degree of turbulence introduced into the arc gases is a measure of deïonization rate and therefore arc extinction. Another major school claims that arc extinction may be had by using solid oil to sweep away arc-decomposed gases until, at zero current, a solid film of oil is inserted between electrodes to prevent re-establishment of the arc. In more popular terms, the former is the Deïon school and the second the oil-blast school. Debate has been had on these two theories for two or three years and the argument continued at the A.I.E.E. midwinter meeting.

D. C. Prince presented a paper on the "Theory of Oil-Blast Circuit Breakers" and R. M. Spurck a paper on the "Practical Application of the Oil-Blast Principle of Circuit Interruption." The other two papers were the "Extinction of A.C. Arcs in Turbulent Gases," by T. E. Browne, Jr., and "Recent Developments in Arc Rupturing-Devices," by R. C. Van Sickle and W. M. Leeds. In his paper Mr. Prince said that the deïonization phenomena had no influence on the extinction phenomena in oil-blast breakers. He broke down the problem into four parts: (1) The voltage recovery rate; (2) the dielectric strength of oil; (3) the necessary velocity of oil, and (4) the means for securing the necessary velocity of oil. He presented test data purporting to show the definite relationships between these elements and developed the principles whereby he deduced that oil could be forced by pressure or by external pistons to sweep past a burning arc at a relatively low velocity so that, when the current reached zero, a film of oil would form in the path of the arc of sufficient dielectric strength to prevent re-establishment of the arc. He placed a value of 55 kv. per one-tenth inch as the necessary oil dielectric strength for oil-blast breaker conditions and asserted that contaminated oil had little effect upon arc-rupturing characteristics. He also showed test data on successful and unsuccessful breaker operation as related to oil velocity and rate of voltage recovery.

R. M. Spurck discussed the performance characteristics of several types of oil-blast breakers and showed test data on them. These data covered a wide voltage and current range and gave arc duration times down to 0.15 cycle.

The turbulent theory of gases as applied to oil breakers was presented by T. E. Browne. This is a development of the deïonization theory of Dr. J. Slepian, whereby it is claimed that the interrupting ability of an a.c. arc increases very considerably with the degree of turbulence to which the arc gases are subjected. Mr. Browne also stated that the recovery of dielectric strength by a turbulent arc space during a zero current period should be very rapid for the first few microseconds and then comparatively slow.

Experimental data with several gases were given, with hydrogen having the most noticeable effect and nitrogen the least. These experiments were to prove that the phenomena of arc extinction is one of deïonization and that this action could be expedited by forcing the gas to be turbulent and by physically controlling the distribution of the arc gases.

Data on the practical application of this principle to oil breakers and fuses were presented by Messrs. Van Sickle and Leeds. Tests were shown, physical arrangements of apparatus were exhibited and performance test data were analyzed. These data showed a wide voltage range of application and arc duration times down to a fraction of a cycle.

Slepian rises to clinch his theory

A lively discussion ensued. Philip Sporn said a great improvement had been had in oil breakers in the past year with both the Deïon and oil-blast types. He urged the adoption of a more modern standard duty cycle for breakers. W. S. Edsall said that closure was important, in addition to opening a circuit, especially on large power house breakers, in that some devices that improve opening operations have a contrary effect upon closing circuits. J. N. Mahoney said the speed of contacts had a very important influence and that arcing times shown in the paper were not superior to some high-speed plain breaks.

Great interest was shown in the discussion of Dr. J. Slepian. The following abstract of his written discussion gives his point of view:

Two years ago, in the closing discussion on my paper, "Extinction of Long A.C. Arcs," *Transactions A.I.E.E.*, 49, page 445, 1930, in commenting upon the suggestion of Mr. Prince that circuits might be interrupted by "whisking the arc products away," I found it necessary to point out that, contrary to general impression, the arc in circuit interrupters performs necessary and useful functions and that "whisking it away," if it were really accomplished, would have serious and unpleasant consequences, unless other means were provided to take over the functions normally exercised by the arc. It seems necessary to expound briefly upon this point again, since the significance of this matter does not seem to have been grasped by the proponents of the oil film theory of operation of practical oil circuit breakers.

The useful function of the arc may be seen by considering what would happen if an arc did not form spontaneously upon separating a pair of contacts in a power circuit. If the arc did not form, then at the moment of separation of the contacts the current would necessarily at once drop to zero. Such an instantaneous reduction of the current to zero would induce disastrously high voltages in the circuit. But it may be suggested, why not separate the contacts at a moment of current zero, when no high voltages will be induced? This

would be an excellent suggestion if the electromechanical problem of synchronizing the separation of the contacts with the current zero was not such an extraordinarily difficult one to solve.

Consider the complicated and variable relations which govern the moment of reaching the current zero in a circuit, and which would make it impossible to start going the contact-separating mechanism much ahead of the current zero. Consider the enormous force necessary to accelerate and get going the contact-separating mechanism in so short a time. Consider the difficulty of controlling this force so exactly as to synchronize with a normal current zero within a few microseconds. Remember, when dealing with such short-time phenomena, bars ordinarily thought of as rigid are annoyingly flexible, and fluids such as oil are highly compressible.

The arc relieves us of these difficulties. We separate the contacts when we please and the arc permits the current to continue to flow so that no high voltages are induced. Then, of itself, in a well-designed switch, of course, the arc seizes upon a moment of current zero for changing from conductor to insulator, thus opening the circuit without the induction of high voltage. Thus no mechanical synchronization with current zero is required. The arc of itself performs this synchronizing function for us, so that circuit breakers using arcs are in practical operation everywhere without causing damage to other electrical apparatus.

The problem of improving circuit interrupters is not one of getting rid of annihilating or "whisking away" arcs, but of using arcs more efficiently, and particularly using more effectively the inherent capacity of the arc for interrupting circuits synchronously with a normal current zero. Mr. Prince, who separates his contacts at a random time, admittedly uses an arc up to a moment of current zero, but just at the moment when the arc is ready to work for him and interrupt the circuit, he aspires to drive the arc away and interpose a growing film of oil between the contacts. However, and fortunately, the means he uses are pathetically inadequate to form such an oil barrier at any time, let alone synchronously with current zero, so that even in his breakers the maligned and much-despised but accommodating arc graciously interrupts the circuit.

It is possible to intensify the mechanical means which Mr. Prince uses so that they will cause a barrier of oil to be interposed between the separating contacts and interrupt the arc, but the mere intensification of these means cannot cause them to form a barrier at current zero and refrain from forming it at any other time.

The discussion of Mr. Prince's paper is made difficult because results, even those which he states are the most convincing, are given without supporting data, but references are given to brief articles in other journals. Looking these up, we find again that sufficient description of his test methods and methods of calculation are not given to permit any critical estimate of their validity, and there is the further difficulty that reports of results of the same tests are frequently mutually contradictory. But waiving these slight objections, when subjected to a moderately careful inspection, the results which Mr. Prince presents wholly fail to support any of the conclusions which he draws. To help Mr. Prince in taking up the criticisms which I shall make, so that none may be inadvertently overlooked, I shall number them:

1. Although it is the fundamental problem of the "oil-blast" theory, neither in this paper nor in the paper of last year is any detailed attention given to the hydromechanical problem of synchronous formation of the growing "solid oil" barrier. Nowhere in the present paper is it stated just where in the oil the velocity occurs which is used as the abscissas of Figs. 2, 3 and 4, although in the next to the last paragraph of the paper it is stated that these curves are the most convincing evidence which the author offers.

1a. In the paper in the ELECTRICAL WORLD, February 19, 1931, from which the data for these figures are taken, a diagram is shown, reproduced here as my Fig. 2, in which it is suggested that the velocity in question is the mean velocity over a section of the passage leading up to the arc. The velocity is calculated from the motion of the piston without considering the influence of the compressibility of the oil, which must be an important factor when the free surfaces *a-a* are so violently accelerated.

1b. The obstructing film is said to form by the uniform motion of the free surfaces *a-a* with the calculated velocity used in Figs. 2, 3 and 4. But when actual fluids possessing some viscosity flow through passages, the velocity next to a bounding wall is generally accepted as being zero, taking on larger values away from the wall, following a parabolic relationship with distance from the wall. Hence the initial rate of growth of the obstructing film at the cone tip must be zero irrespective of the mean velocity of the oil.

1c. Waiving the objection of 1b, the rate of growth of the obstructing film at the cone tip will be equal to the "oil velocity" divided by the sine of one-half the conical angle made by the free surface *a-a*. Hence when this angle is small the necessary rate of growth of the film should be obtainable with very low oil velocity. No discussion is given in the ELECTRICAL WORLD paper as to what determines this angle. In his closing discussion last year, *Transactions A.I.E.E.*, 50, page 529, 1931, Mr. Prince, in order to account for the greater interrupting capacity of long arcs in oil-blast breakers, suggests that for long arcs the angle is smaller. It would seem equally plausible that for small current arcs this angle should be small. Hence it would seem that for long arcs and small currents in circuits of the same speed smaller "oil velocities" would be necessary. But this contradicts the conclusions which Mr. Prince draws from his Figs. 2, 3 and 4.

1d. No explanation is given why the free surface *a-a* happens to be at just the right place at current zero immediately to start forming the obstructing film. Mr. Rankin, in the *General Electric Review*, October, 1931, suggests that long before the current zero, the surface *a-a* exists at the proper position with oil rushing up perpendicularly to the surface with the supposed high velocity, but with the oil being decomposed by the arc as fast as it crosses the surfaces. But with oil coming up with a velocity of 100 ft. per second, and being decomposed, approximately 20,000 liters of gas at atmospheric pressure and temperature would form per second or about 200 liters per half cycle, for a single square inch of surface *a-a*. This is ten to one hundred times as great as the whole volume of gas usually formed in a complete circuit breaker operation. The electrical energy which the arc would need to receive to decompose oil at this rate would be enormous, so that a high arc voltage would be necessary to keep the arc going. Since the high voltage is not available from the circuit, this is another way of saying that the arc will not be able to keep back the advancing oil surfaces, but that it will be squeezed out with development of high voltages. This same argument applies against the oil having a large perpendicular velocity to any surface abutting on the arc and being kept from closing in on the arc by the decomposition of the oil. If the surfaces are kept from closing in by the gas pressure at the arc, then, of course, they cannot have the high velocity which Mr. Prince states is necessary. Hence, if surfaces do exist, closing in on the arc with high velocity, there is no reason why their closing in and final cutting off of the arc should be synchronous with a normal current zero.

1e. In his paper of last year, *Transactions A.I.E.E.*, 50, page 508, 1931, Mr. Prince says of the oil adjacent to the arc, it "exists alongside it without mixing," and thus suggests that the velocity is tangential to the surface abutting the arc. Likewise, in *General Electric Review*, December, 1931, page 722, Fig. 1, a tangential flow of oil is shown. But such a tangential velocity cannot contribute to the growth of an obstructing film and therefore there should be no relation between such a velocity and the interrupting capacity in contradiction to the conclusions which Mr. Prince draws from his Figs. 2, 3 and 4.

2. We come now to the data shown in his Figs. 2, 3 and 4, which Mr. Prince regards as the most convincing proofs of his ideas. From these curves Mr. Prince deduces that arc extinction depends upon the relation between the circuit recovery voltage rate and oil velocity alone. Since Mr. Prince gives no account here of the experiments from which this data were taken, it is necessary to refer to the paper, ELECTRICAL WORLD, February 19, 1931.

2a. In 1a and 1b I have pointed out that the calculated velocity used by Mr. Prince in these curves corresponds to no real velocity in the oil.

2b. In 1c I have pointed out that according to Mr. Prince himself, for a given "oil velocity" the rate of formation of obstructing film should be greater for long arcs and, by a similar argument, for small current, and therefore is not a function of the "oil velocity" alone. There is no unique rela-

tionship between the rate of growth of an oil barrier and the "oil velocity."

2c. The rates of voltage rise in the various circuits are given as calculated from high-frequency measurements, but no examples of these calculations are given, so that they may be critically examined.

2d. The rate of voltage rise just after current zero in one and the same circuits will vary widely, depending on the point of the voltage wave at which the circuit was closed. No account seems to have been taken of this factor.

2e. For these points marked as failures, was the arc extinguished at a later zero? If so, were those arc extinctions marked as successful in Figs. 2, 3 and 4? If not, why not?

3. Examining the data of Fig. 10, ELECTRICAL WORLD, February 19, 1931, page 403, covering supposedly the same tests as Figs. 2, 3 and 4 of this paper, the contention that the condition for interruption is independent of the voltage of the circuit tested is not supported. This may be seen by separating the data for the 13,200-volt, 6,600-volt and 3,800-volt connections as I have done.

3a. In my Fig. 3 a curved line would fit the data better than the straight one shown, but there is not a sufficiently dense region of complete failures to draw any curve with any confidence.

3b. From my Fig. 4 no limiting curve can be drawn whatsoever. The data therefore give no information whatsoever as to whether the "oil velocity" required for a given circuit speed is the same for 6,600 volts as at 13,200 volts. Why are not data given for "oil velocities" less than 60 ft. per second and so little data for circuit speeds of more than 450 volts per microsecond, since the curves of Fig. 9, ELECTRICAL WORLD, February 19, show that such circuit speeds were readily obtainable?

3c. From my Fig. 5 we can at most conclude that the limiting curve has one point in common with the "55 kv. per 1/10-in." line, and even this conclusion seems hardly justifiable with the small amount of data shown. Again, why are not data for higher circuit speeds than 425 volts per microsecond given, since according to Fig. 9, ELECTRICAL WORLD, February 19, such speeds were readily obtainable?

4. At the bottom of page 3, referring to Fig. 5, it is stated that in the plain explosion chamber the arc is uniformly extinguished at the throat. This is glaringly contradicted by Fig. 9 of the paper by Spurck and Strang, *Transactions A.I.E.E.*, 50, page 519, 1931.

5. At the top of page 4, Fig. 6 and text, it is stated that tests with multiple throat explosion chamber support the oil-blast theory of operation. Data are not given which will permit critical examination of this conclusion.

6. Again, on page 4, tests in a narrow slot are said to support the oil-blast theory, but data are not given which will permit critical examination of this conclusion.

7. The Metropolitan Vickers explosion chamber shown on page 4 is not described in sufficient detail to make clear its construction. Does it differ essentially from the Westinghouse Deion grid? Does it act on the arc magnetically?

8. On page 4, describing the action of the Metropolitan Vickers explosion chamber, it is stated that the "pressure in the explosion chamber may force oil across the tip of the receding contact rod at a number of points in the stroke." But the tip of the rod can be at only one such point at any one time. It should be a matter of chance whether this occurs at a current zero early in the stroke or later. Hence, in tests in interrupting a given circuit, short arc lengths should predominate with an occasional long arc length. But the data of Table I show a rather uniform arc length of 6 in. or more. This suggests strongly that the action is one throughout the length of the arc rather than one confined to the tip of the moving rod.

9. From the bubble size in Fig. 9 it should be possible to compute the velocity of the oil flowing out of the chamber. It would be interesting to know this figure.

10. At the top of page 6 what is meant by "the arc is greatly subjected to violent washing action?" Is it possible that this is another way of saying that there is a "turbulent in-mixing of freshly generated gas?"

J. B. MacNeill, in discussing the papers, said differences in breaker theory should not distort the practical fact that better breakers are now available and that old breakers can be improved readily at relatively small expense. In his opinion breakers and relays no longer place limitations on power system expansion.

R. M. Spurck closed the discussion in behalf of the oil-blast papers. He said that it was not contended that the oil blast "whisked away the arc." If this were so high voltages would result and very high velocities of oil would be required. He said the 55-kv. dielectric value was a reasonable and not a precise figure for the oil under the oil-blast principle of operation. The principle of the oil blast was to sweep away arc products so that, when the current was zero, a solid oil film occupied the very small space left by the decaying arc. He also pointed out that the interrupting value of oil based on the oil-blast principle did not affect the dielectric requirements of oil as an insulator. He also said steps were being taken to improve and modernize the present standard breaker duty cycle.

▼

Sectionalizing Tower Simplifies Maintenance

Rebuilt tower economically provides sectionalizing point

The double-circuit Turner-Logan 132-kv. lines of the Appalachian Electric Power Company stretch for a considerable part through a wild and comparatively inaccessible territory which is particularly difficult for maintenance crews to patrol in time of trouble. To minimize the time required to locate and isolate a section of the line which is in trouble and yet not involve prohibitively expensive expedients, a sectionalizing tower—a dead-end tower rebuilt for the purpose—was devised by the engineers of the American Gas & Electric Company. Several interesting features were introduced. These include air-break sectionalizing switches operated through underhung pillar-type insulators and the installation of carrier-current coupling capacitors of the cable type. These capacitors make it possible for the troubleman to communicate with the main dispatching office at one end of the line by means of a portable carrier set.

Predetermining Dielectric Characteristics*

By J. B. WHITEHEAD and A. BANOS

EXPERIMENTS show that the alternating-current behavior of a dielectric at 60 cycles may be accurately predicted from suitable d.c. measurements. The fact that dielectric loss may be explained in terms of reversible absorption, or residual charge, and anomalous conduction, as observed under continuous potential, has led to several well-known extensions to the alternating case of various theories of dielectric absorption.

Continuous potential measurements and corresponding 60-cycle a.c. measurements were made on a number of samples of oil, paper and impregnated paper at voltages of 500, 1,000 and 1,500 and at temperatures of 30, 45 and 60 deg. C.

The measurements under continuous voltage include the determination of the charge and discharge current-time relations with the aid of the amplifier-oscillograph. The amplifier increases the normal sensitivity of the electromagnetic oscillograph 10^5 times, giving a deflection on the photographic film of 1 mm. per 4×10^{-8} amp. The a.c. measurements include the determination of power factor and apparent capacitance using a modified Schering bridge whose power factor sensitivity is $\pm 5 \times 10^{-6}$.

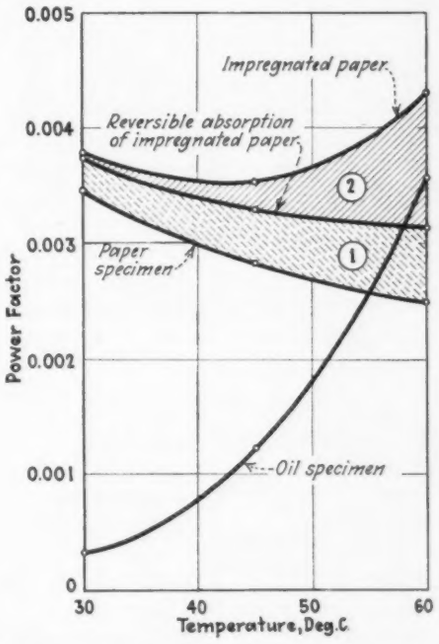
Paper Specimens—Dry paper specimens reveal a dielectric loss due entirely to reversible absorption; that is, the irreversible conduction current is not measurable as shown by the equality of charge and discharge currents.

Oil Specimens—The charge current is characterized by a large initial constant current which accounts for the major part of the loss. Superimposed on this initial current is a smaller decaying current function of time which is reversible and, therefore, attributable to dielectric absorption in oil. The equations for discharge show that the small element of dielectric absorption is expressible by a single exponential, thus corroborating the results published by Whitehead in "The Conductivity of Insulating Oils, II."

Summary of Specimens—As an example of the insight afforded by this method of analysis the accompanying illustration gives the power factor as a function of temperature for the oil, paper and impregnated paper specimens. The shaded areas represent the total increase in power factor with impregnation. Through the analysis of the discharge current-time relations it is possible to resolve this increase into two components.

1. The increase in reversible absorption brought about by impregnation.

2. The creation of the additional contribution of irreversible conduction totally absent before impregnation and directly attributable to the conductivity of the impregnating oil.



Analysis of power factor at 1,500 volts

Increase in power factor with impregnation.
(1) Increase in reversible absorption.
(2) Contribution of irreversible conduction.

Conclusions

1. It is shown that for any type of dielectric the loss, power factor and capacity at 60 cycles may be accurately predicted from the charge and discharge currents under continuous potential.

2. The method developed is available at any frequency, provided that the continuous potential charge and discharge currents may be measured over initial time intervals comparable with the alternating period.

3. The nature of the relaxation function characteristic of reversible absorption in dielectric has been discussed from the experimental and analytical points of view.

4. It has been shown that agreement of the relaxation function with the Hopkinson t^{-n} expression is not general, but on the contrary it is confined to dielectrics showing negligible or no irreversible conduction. The inadequacy of the t^{-n} expression has been proved on experimental and analytical reasons. Chief among them is the failure of the t^{-n} expression to predict accurately the variation of dielectric loss with frequency.

5. The method of three exponentials has been developed as a convenient and sufficient expression for the relaxation function. The sufficiency and accuracy of three exponentials has been proved both analytically and experimentally.

6. Irreversible conduction does not obey the principle of superposition. The usual forms of irreversible conduction that have been encountered have been defined and classified. The case where the initial constant current does not obey Ohm's law has been considered analytically in its contribution to the behavior.

7. The manner in which the complete a.c. behavior of a dielectric is accurately predicted from suitable d.c. measurements has been illustrated by three typical sets of experimental data, paper, oil and impregnated paper.

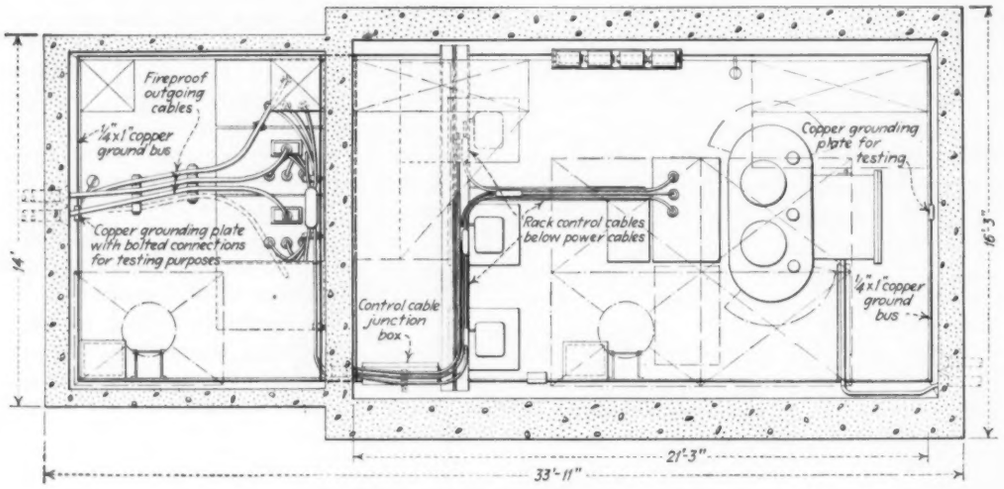
**Abstract of paper entitled "The Predetermination of the A.C. Behavior of Dielectrics, presented at the winter convention, New York, January 27, 1932.*

Equipment arrangements in oil-circuit-breaker cubicles

Metal manholes and removable concrete mat covers at the Hulton vault

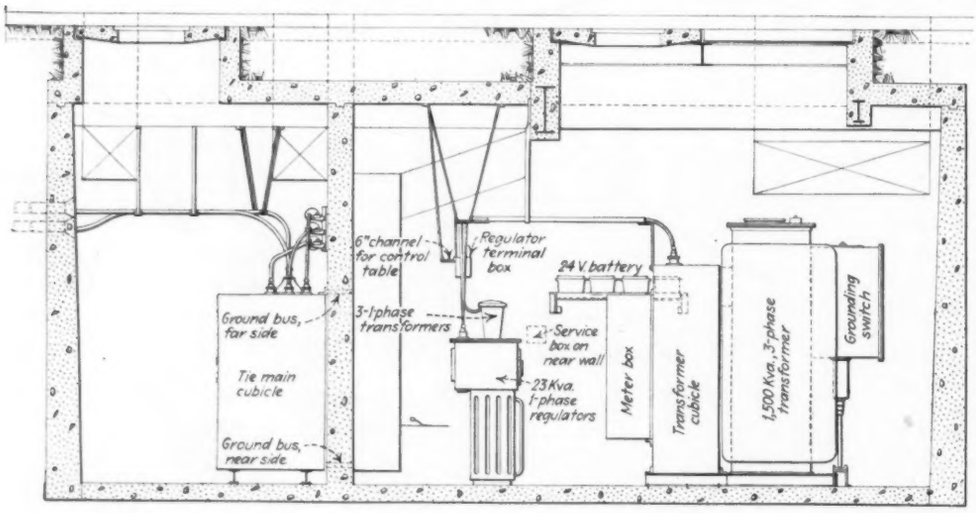
High-Voltage Network Vault Simplified for Continuity

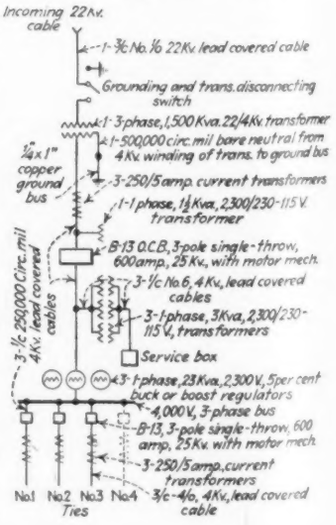
In constructing the first 1,500-kva. underground network vault for the Verona network of the Duquesne Light Company, engineers of the Byllesby Engineering & Management Corporation endeavored to insure a high grade of service continuity. All main equipment is of water-tight construction, and auxiliary devices are mounted at a high level within the vault. One compartment of the vault contains one 1,500-kva., three-phase, 22,000/4,000-kw. transformer with integral 22,000-kw. grounding switch; a separate 4,000-volt transformer breaker cubicle, meter box, and three 23-kva., single-

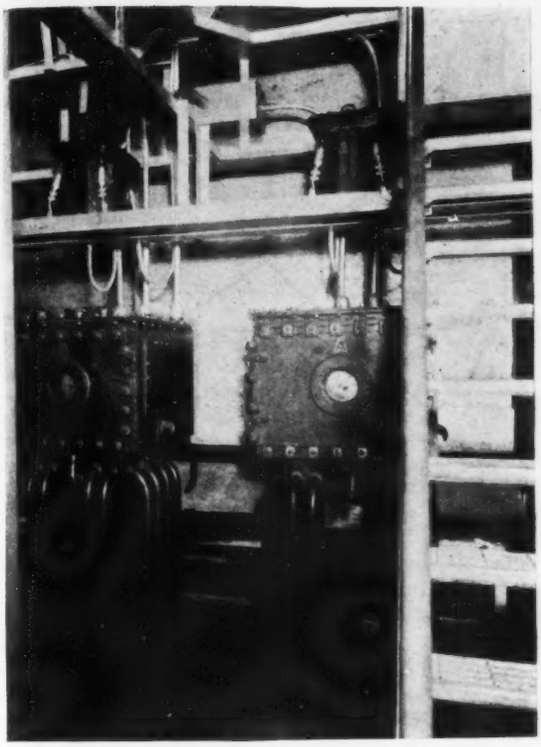


1,500-kva.-22/4-kv. network vault

Pittsburgh vault is of simplified design




Incoming 22 Kv. cable
1-3/c No. 1/0 22 Kv. lead covered cable
Grounding and trans. disconnecting switch
1-3 phase, 1,500 Kva. 22/4 Kv. transformer
1-500,000 circ. mil bare neutral from 4 Kv. winding of trans. to ground bus
¼"x1" copper ground bus
3-250/5 amp. current transformers
1-1 phase, 1½ Kva., 2,300/230-115 V. transformer
B-13 O.C.B., 3-pole single-throw, 600 amp., 25 Kv., with motor mech.
3-1/c No. 6, 4 Kv., lead covered cables
3-1 phase, 3 Kva., 2,300/230-115 V. transformers
Service box
3-1 phase, 23 Kva., 2,300 V., 5 per cent buck or boost regulators
4,000 V., 3-phase bus
B-13, 3-pole single-throw, 600 amp., 25 Kv. with motor mech.
3-250/5 amp. current transformers
3-1/c 250,000 Circ. mil 4 Kv. lead covered cables
No. 1
No. 2 Ties
No. 3
No. 4
3/c-4/0, 4 Kv., lead covered cable



Water-tight regulators, showing position indicators

phase voltage regulators. The other compartment contains three feeder oil-circuit-breaker cubicles with space for a fourth. Removable concrete covers permit ready replacements and maintenance of equipment.

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British Electrical Research in 1931

During 1931 valuable electrical research was carried out in the electrical standards and measurements division of the British National Physical Laboratory, Teddington. Measurements of the effective self-inductance and resistance of telephone loading coils were extended up to a frequency of 10,000 cycles a second. The volume leakage correction in the measurement of the surface resistivity of insulating materials has received consideration, and an experimental method for the determination of this correction has been devised. A method of compensating for the frequency error of alternating-current milliammeters incorporating copper-oxide rectifiers has been found. The magnetic properties of a full range of iron-chromium alloys have been studied. Investigations on the power losses in dielectrics and on dielectric measurements at high frequencies were carried out for the British Electrical and Allied Industries Research Association.

In the electrotechnics division, among other things, attention was directed to the general development of alternating-current measuring methods, and in particular to the accurate calibration of current transformers provided with cores of nickel-iron alloys in which the phase interval between the primary and secondary circuits is very small. In the photometry division also important investigations were carried on.

Testing Two-Element Meters on a Six-Phase Converter

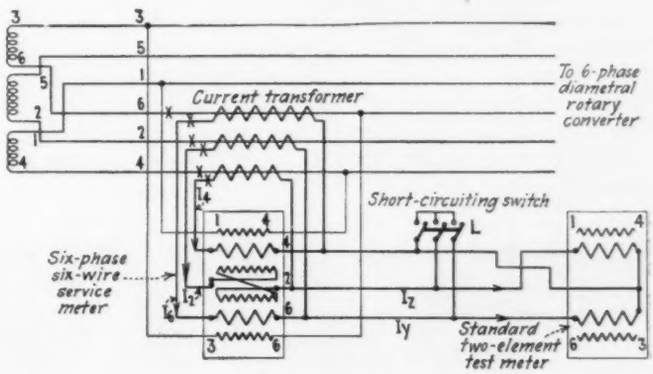
By W. C. NODDINGS

Chief Electrician Raritan Copper Works, Perth Amboy, N. J.

Two-element meters with four current coils can be used to register accurately the consumption of a six-phase rotary. In one installation it was desired to check such a meter without interrupting the load or the registration because the process was continuous zinc reduction. The test meter available was a standard two-element polyphase meter. As will be seen from the diagram, the results were obtained by using three current transformers—one in each phase—connecting them in delta with the proper current coil of the meter in series with its current transformer within a leg of the delta.

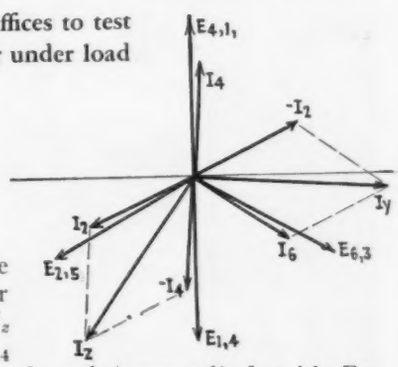
Without some supplementary connection, however, this delta connection would not be workable because the vector sum of the currents in the delta would be zero and the effect on the current and transformers would be the same as a high impedance or open circuit. Introduction of the short-circuiting switch or test links at L corrects the defect for normal operation. The two-element test meter can then be inserted, with its current coils connected to bridge these links, which are opened during the meter test.

That the connection shown for the test meter will register the same total six-phase consumption as the



Two-element meter suffices to test six-phase service meter under load

Both meters register the six-phase kilowatt-hours



service meter can be seen from the vector diagram. Current I_z which, if used with $E_{1,4}$ voltage, is equivalent to I_4 and (reversed) I_2 with $E_{4,1}$ voltage; likewise, the other element of the test meter accounts for the rest of the kilowatt-hours by means of current I_y which is the vector sum of I_6 and (reversed) I_3 reacting with voltage $E_{6,3}$.

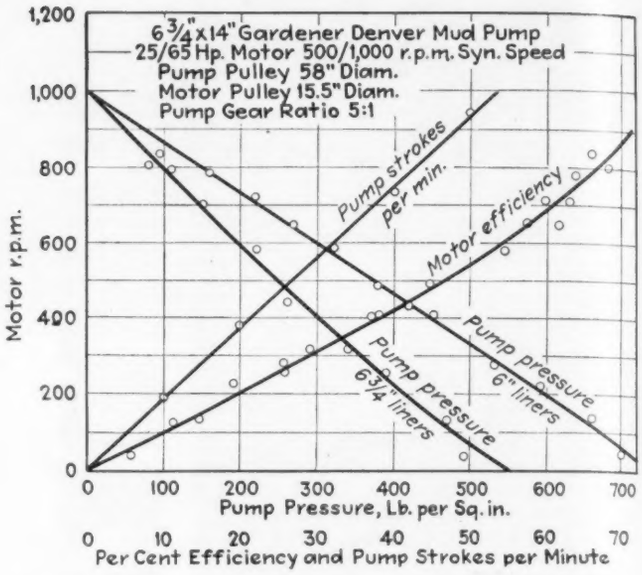
A.C. Motor Drive Has Steam Characteristics

One of the principal objections to electrical equipment for drilling oil wells has been the undesirable characteristics of constant-speed, alternating-current motors for driving the mud pumps. In oil well drilling mud is forced down the hollow drill pipe under pressure to provide a semi-abrasive lubricant for the drill bit and also to provide a carrier for the material drilled. The possibilty of developing excessive pressure in the pump in case of stoppage of the mud flow, the difficulty of securing satisfactory compound or parallel operation of pumps and the tendency to deliver a constant volume of fluid, regardless of pressure, were among objections to electric drive.

The speed-torque characteristics of the steam engine were admittedly the most satisfactory and the problem of the motor manufacturer has been to approach these characteristics, especially with an alternating-current motor. Direct-current motors are objectionable due to the added motor-generator set necessary.

Not until a wound-rotor motor with a combination of resistance and reactance in the rotor circuit was brought out was the problem solved. Besides adding resistance and reactance in the rotor circuit the pump pulley was reduced in size and a blower was mounted on the motor to carry away the additional heat produced and to compensate for the lessened self-cooling action of the motor due to operating part of the time at reduced speed.

Tests were made to determine the optimum value of resistance and reactance. The value chosen was such that the motor will stall at 250 per cent load and so remain for several hours without excessive heating. Slowing down of the motor under increasing load is such that inertia tending to develop destructive pump pressures is practically eliminated.

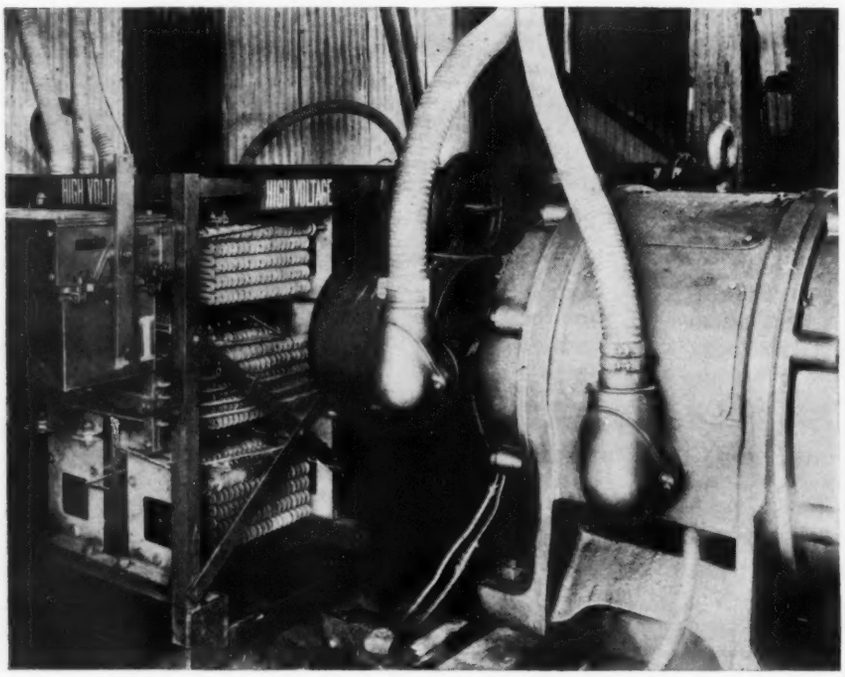


Characteristics of resistance-reactance controlled motor

Motor efficiency and pump pressure curves taken on mud pump installation using a combination of resistance and reactance to permit stalling of motor without developing destructive pump pressures.

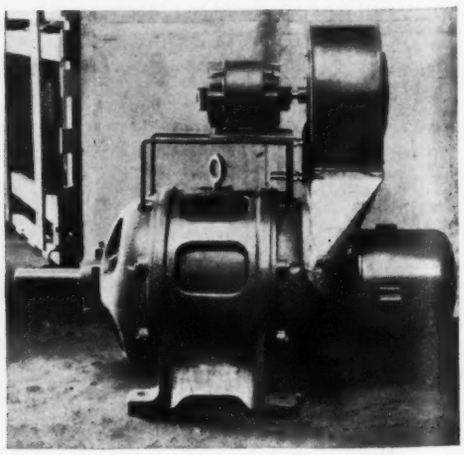
The efficiency of such a combination is naturally lower than with a standard wound-rotor motor operating normally with resistance all cut out. However, where the total cost of drilling runs $600 per tower (per eight-hour shift) and the cost of electrical energy amounts to only $20 to $30 per day, the addition of $2 a day due to lowered efficiency is so small a proportion of total cost that it is of little consequence. The accompanying curve gives efficiency and pump pressure throughout the range of operating conditions.

Credit for this new development is due engineers in the Los Angeles office of the Westinghouse Electric & Manufacturing Company.



Gas-protected mud pump motor with resistance-reactance control bank

An auxiliary blower conducts away the additional heat produced at reduced speeds



Men of the Industry

D. E. Ackers Vice-President of Kansas Utility

Deane E. Ackers, who was appointed vice-president of the Kansas Power & Light Company, as announced in the December 26 issue of the ELECTRICAL WORLD, is a native of Kansas, a graduate of the Kansas University and has spent his entire business career with Kansas utilities.

Though Mr. Ackers received his degree in 1917 he did not enter industry until 1919, the intervening years having engaged in military service. His first connection was with the United Power & Light Company at Abilene, where he remained until 1923, when he entered the employ of the Kansas Power & Light Company (the Atchison Railway Light & Power Company) at Atchison as operating engineer. Four years later he became manager of the Topeka district; subsequently he was named assistant general manager and in 1929 assumed the general managership. Mr. Ackers has been active in association work, in 1929 having been elected president of the Kansas section of the National Electric Light Association.

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FRANK W. BIRD, for the past twenty years affiliated with the Montana Power Company, with headquarters in Butte, Mont., has been appointed assistant general manager for that company and its subsidiary companies. Mr. Bird has been connected with the Montana utility for more than twenty years and during this long period he has been charged with the performance of many important duties. For the past decade or more he has been called on to discharge many of the duties of the office to which he has now been formally appointed. Mr. Bird, who is a civil engineer by profession, has been a resident of Montana since 1903.

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W. C. Sharp Retires

W. C. Sharp, vice-president of the Middle West Utilities Company in charge of operations since the summer of 1924, has retired. Mr. Sharp relinquishes his executive duties with this company after completing more than 30 years of service in the public utility industry. Starting with the New York Edison Company in 1900, he became identified with the meter department and later had charge of coal and boiler testing. Subsequent connections followed with the Des Moines Electric Light Company, the J. G. White interests and with the Helena Light & Railway Company. In 1915 he became connected with A. E. Fitkin & Company as president of their properties, holding that position until his affiliation with the Middle West Utilities Company in 1921, where he devoted his time to reporting on properties.

▼

DR. ARTHUR E. KENNELLY of the Harvard Engineering School has been elected an honorary member of the Electrotechnischer Verein, Germany, and of the Japanese Institute of Electrical Engineers. Dr. Kennelly has just returned from the Orient, where he delivered a series of lectures before five Japanese universities under the Iwadare Foundation.

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GEORGE T. BIGELOW, since 1921 assistant general agent for the Southern Sierras Power Company, with headquarters in Riverside, Calif., has been appointed manager of the company's commercial department. In 1918 Mr. Bigelow left the office of the secretary of the Riverside Chamber of Commerce to become affiliated with the power company's organization, where he took a position in the executive department. In 1919 he was transferred to the commercial department as special agent, and two years later he was appointed assistant general agent, a position which he has occupied until his promotion to the commercial managership. He has taken an active part in the affairs of the Pacific Coast Electrical Association, particularly in the commercial section, of which he served as chairman during 1930.

E. D. Bell New Vice-President of United Power & Light

E. D. Bell, who was elected vice-president of the United Power & Light Corporation of Kansas, as announced in the December 26 issue of the ELECTRICAL WORLD, has been identified with the public utility industry in the Middle West since 1901, the year in which he was graduated in mechanical engineering from the University of Illinois. He took charge of the Urbana Light, Heat & Power Company, which was shortly afterward bought by the McKinley interests. In 1905 he was transferred to Danville as superintendent of the light and heating department, remaining until the summer of 1906.

Then he transferred his interests to Madison County, Ill., in charge of what became the Madison County Light & Power Company, remaining there until the fall of 1925. Later he was appointed manager of the Champaign district of the central division, remaining until May of 1927. At that time he became general manager of the United Power & Light Corporation, the position he occupied until his recent appointment.

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HARVEY C. COUCH, who is known in the South as the "empire builder" for the part he has played in the electrical development of Louisiana, Arkansas and Mississippi, has been appointed a director of the new Reconstruction Finance Corporation by President Hoover. Mr. Couch is president of the Arkansas Power & Light Company, the Louisiana Power & Light Company and the Mississippi Power & Light Company.

•

SIR OLIVER LODGE, scientist, has been made the recipient of the Faraday medal by the council of the Institution of Electrical Engineers of Great Britain. His experiments with high-frequency oscillations led to the discovery and invention of the coherer in

1894, which contributed to the advancement of wireless telegraphy. Sir Oliver is 80 years of age. The Faraday medal is awarded not more than once a year for notable scientific or industrial achievement in electrical engineering.

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GEORGE H. BUCHER, formerly assistant general manager of the Westinghouse Electric International Company, has been elected vice-president and general manager of that company. His headquarters will remain in New York City.

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J. J. MCKENNA, vice-president and treasurer, has been appointed to the executive committee of both the Louisville Gas & Electric Company of Delaware and the Louisville Gas & Electric Company of Kentucky, to fill the vacancy caused by the death of Lewis S. Streng. ROBERT MONTGOMERY, vice-president in charge of sales, was elected to fill the vacancy on the board of directors of the Delaware corporation.

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L. L. WAGGONER, until recently head of the municipal light plant at Emmetsburg, Iowa, has been named superintendent and manager of the Lake Mills (Iowa) municipal light plant.

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C. G. JONES, who has been acting as inductive heating engineer for the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has resigned to become special engineer for the Youngstown Sheet & Tube Company, Youngstown, Ohio.

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HAROLD W. BIBBER left the central station engineering department of the General Electric Company January 1 to become associate professor of electrical engineering at Ohio State University. Educated at Massachusetts Institute of Technology and the École Superieure d'Électricité in Paris, he spent the years 1920-21 in France, representing M. I. T. as an exchange instructor to the École Centrale des Arts et Manufactures, Paris. On his return he was an instructor in electrical engineering at M. I. T. for two years. He then joined the staff of the International General Electric Company at Schenectady. In 1923 he went to the Japan office of the company, spending 3½ years there in central station and railway work. On his return to this country he was with the head office staff of the company until 1929, when he was transferred to the central station engineering department of the domestic company. Mr. Bibber is a member of the American Institute of Electrical Engineers and of the Society for the Promotion of Engineering Education.

J. P. Clayton Directs Operations for Middle West Utilities

J. Paul Clayton, who for many years has been vice-president of the Central Illinois Public Service Company, with offices at Springfield since the removal of headquarters from Mattoon in 1919, has been appointed to the position of vice-president in charge of operations of the Middle West Utilities Company, Chicago. Mr. Clayton succeeds W. C. Sharp, retired, and is succeeded as vice-president of the Central Illinois Utility by E. F. Kelly, formerly assistant to the vice-president.

Mr. Clayton attended Tulane University, having been graduated in 1909 after majoring in mechanical and electrical engineering. During the next two years he was a research fellow in the engineering experiment station at the University of Illinois, and from 1911 to 1912 he was a member of the staff at this station. In 1912 he joined the Union Gas & Electric Company at Cincinnati, as commercial engineer. In September, 1912, he entered the employ of the Central Illinois Public Service Company as power salesman and the following month he was promoted to the position of manager of the company's commercial department. In September, 1917, he was transferred to Chicago as commercial manager of the Middle West Utilities Company, and on January 1, 1919, he returned to the Central Illinois Public Service Company as vice-president.

Mr. Clayton has always been keenly interested in civic and chamber of commerce activities and at the time of his last promotion he was serving his second consecutive year as president of the Illinois Chamber of Commerce. He resigned this office when he retired as vice-president of the Central Illinois Public Service Company.

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RICHARD LINCOLN, superintendent of the merchandising department of the Edison Electric Illuminating Company of Boston, was elected president of the Metropolitan Electrical League of Boston at the recent annual meeting of the latter organization. JOHN J. SULLIVAN, Lord Electric Company, Boston, was made vice-president and J. J. CADDIGAN treasurer.

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M. S. LUTHRINGER, formerly a division manager of the Central Illinois Public Service Company, has been elected assistant to the vice-president of that company.

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OBITUARY

W. D. Kyser

W. D. Kyser, president of the Memphis Power & Light Company, Memphis Street Railway Company and the Memphis Natural Gas Company, died suddenly, of heart disease, February 1 at his home in Memphis, Tenn. A lawyer by profession, Mr. Kyser became head of the Memphis utilities two years ago, when T. H. Tutwiler resigned. He was a native of Richmond, Ala., and practiced law in Memphis following his graduation from Cumberland University. He was assistant U. S. District Attorney for the western district of Tennessee from 1914 to 1917, when he was made United States District Attorney, which office he held until 1921. Mr. Kyser was approaching his fiftieth year.

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WALTER DASKAM, a vice-president of the Stamford Gas & Electric Company, Stamford, Conn., died January 25 at the age of 66. Mr. Daskam is also president of the Stamford Trust Company.

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W. H. BULLOCK, electrical engineer of Denver, Colo., died January 21 in his fiftieth year. Mr. Bullock was a graduate of the University of Colorado. He was connected with the Westinghouse Electric & Manufacturing Company in Denver as general engineer for a number of years and at the time of his death was associated with H. S. Sands, consulting engineer of Denver. He was a member of the American Institute of Electrical Engineers and the Electrical League of Colorado.

•

ARTHUR E. CALDWELL, since 1923 in charge of the telephone service for the entire system of the Pacific Gas & Electric Company, with headquarters in San Francisco, died at his home in San Jose January 26, from a heart attack. He joined the Pacific Gas & Electric Company's organization as a salesman in 1911 and later became superintendent of new business for the San Jose division, a position he held until he was put in charge of the company's communication system.

Trade News

Diamond Electrical Buys S. L. Mosher

Effective January 1, the Diamond Electrical Manufacturing Company, Ltd., of Los Angeles and San Francisco, has purchased the S. L. Mosher Company of Denver. The Diamond company is affiliated with the Square D organization of Detroit and is well known to the electrical fraternity. The territories to be served from the Denver plant embrace the states of Colorado, Utah, Wyoming, New Mexico, Montana and Idaho.

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Bailey Meter Company, Cleveland, Ohio, announces the appointment of W. J. Reeder as manager of its St. Louis branch office. For the past seven years Mr. Reeder has been connected with the Chicago branch office of the company, where he has had a wide experience in the solution of metering, controlling and regulating problems.

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Announcement has been made of the appointment of A. E. Snyder, manager of the miniature lamp sales department, Westinghouse Lamp Company, to the position of manager of the lamp sales department, comprising both the large and miniature lamp sales departments.

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Outdoor-Lighting Controls, Inc., is a new corporation formed to market a complete line of flashers, time switches and other accessories used to control motion and color in outdoor electrical advertising. Headquarters are located in New York. James H. Betts is president of the new company.

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Synthane Corporation, Oaks, Pa., manufacturer of Synthane laminated bakelite, sheets, rods, tubes, fabricated parts and stabilized gears, has appointed Industrial Products Sales Corporation as sales representative for St. Louis and the surrounding territory.

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Electromaster, Inc., announces the appointment of Paul R. Dolvin as district sales manager for the "Electrochef" electric range in the Southeastern territory with headquarters in Atlanta.

•

Blaw-Knox Company announces the appointment of M. I. Dorfan as manager of its dust collector division. Mr. Dorfan has just terminated a five-year engagement as manager of the dust collector division of the Pangborn Corporation of Hagerstown, Md. He was previously in charge of dust collector sales for the Allis-Chalmers Manufacturing Company of Milwaukee.

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A. H. Jaeger, general sales manager of Electromaster, Inc., announces the appointment of Bert Harding as district manager of "Electrochef" sales in the southwest territory.

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The Standard Electric Stove Company, Toledo, announces appointment of the following distributors: B. W. Smith, Inc., Cleveland, handling northeastern Ohio; Columbus Ignition Company, Columbus, handling central and southeastern Ohio; Independent Electric Company, Muskegon, Mich., handling central western Michigan; Miller Brothers Hardware Company, Richmond, Ind., handling central eastern Indiana.

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To meet the demand for a ready reference book on aluminum and its alloys, the Aluminum Company of America has issued "Alcoa Aluminum and Its Alloys." The book gives in concise form information concerning the physical and chemical properties of the aluminum alloys produced by the Aluminum Company of America and contains tables showing the sizes of the basic commodities the company manufactures from these alloys.

•

Combustion Engineering Corporation announces the appointment of Charles McDonough as publicity manager to succeed Carl Stripe.

•

Parr Electric Company has purchased the factory formerly occupied by the Gouch Paper Box Company at Newark, N. J. The seller was the South Broad Building & Loan Association.

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Announcement is made by the Allis-Chalmers Manufacturing Company that L. W. Grothaus, assistant manager of the electrical department at the home office, Milwaukee, has been appointed general representative of the company to succeed C. F. Searle, who resigned to accept the vice-presidency of an Eastern firm. Mr. Searle's plans will be announced shortly.

•

"The Most Efficient Lighting for Schools and Colleges" is the title of the new Holophane publication which has just come off the press. This bulletin presents in a concise, comprehensible form an outline of the most modern practice in the lighting of educational buildings, giving complete information as to the exact manner in which Holophane specifics meet such requirements.

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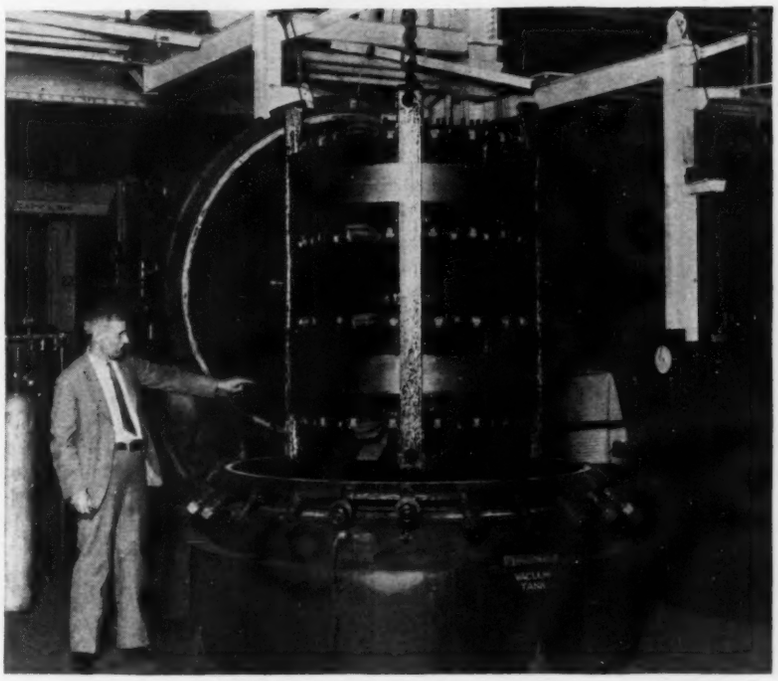
PROCESSING MOTOR STATORS FOR PENNSYLVANIA R.R.



One of the details in the construction of motors ordered by the Pennsylvania Railroad from the Westinghouse Electric & Manufacturing Company is the processing of wound stators in vacuum and varnish tanks. The illustration shows two stators, fastened in one frame, being lowered into the vacuum tank.

New Equipment Available

Economy and Low Upkeep in New Riley Stoker

In announcing its new Model R the Riley Stoker Corporation of Worcester, Mass., points to six notable improvements, all incorporated and co-ordinated to insure greater economy of combustion and lower maintenance cost, as well as increased operating flexibility.

These features include a two-speed roller-bearing gear box with planetary clutch, giving reduced power requirements; lower hopper sections with observation slots so arranged that each section may be separately removed without emptying coal from the hopper or shutting down the stoker; a new grate surface with greater efficiency and burning capacity; improved distribution of air flow; more rugged rocker dump with either power or manual operation, and free-expanding substructure which obviates the necessity of intermediate supports.

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Photo-tube Light-Control Unit

A photo-tube light control unit that has a variety of applications and may be set up and operated by inexperienced workers is announced by the Electrotec Engineering Corporation, New York. This unit, the relay manufacturer declares, has been so designed that it will meet any possible light control requirements. The unit has an external adjustment that may be set to operate on a change of one-tenth of 1 foot-candle of illumination, from absolute dark to daylight or for impulse operation from light source. This photo-tube relay is manufactured in three models, to operate from a.c., d.c. and battery. It is equipped with cord and plug and terminals for open and closed circuit operation.

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Adjustable Utility Light

An adjustable utility light for use as a mechanic's worklight and inspection light, designated "WheelaLite," has been announced by the Wheeler Reflector Company, Boston, Mass. The lighting unit is mounted on a truck equipped with four casters so that it can be rolled anywhere and the reflector itself is adjustable vertically so that the light can be directed wherever desired. The glass lens in the mouth of the reflector is protected by a wire guard. The unit accommodates a 75- or 100-watt inside frosted lamp and is wired complete with socket, 25 ft. of rubber service cable and plug

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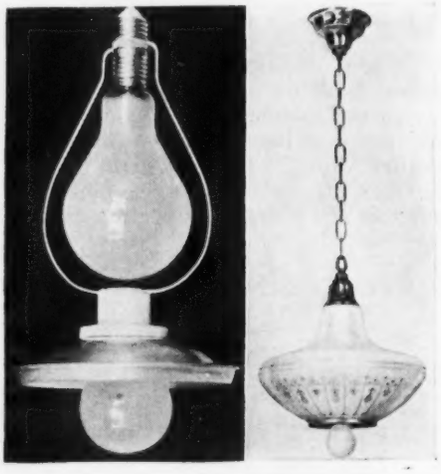
Dual-Purpose Lighting With a Violite Adapter

A "Violite" adapter which makes it possible to obtain dual-purpose lighting, a combination of general interior illumination plus ultra-violet irradiation, easily and economically is announced by the Westinghouse Electric & Manufacturing Company. It consists of a



socket for a 200-watt ballast lamp and an aluminum reflector and socket for a type G-1 ultra-violite glow lamp. The G-1 lamp is in series with the incandescent or ballast lamp, which acts as a ballast resistance. No transformers or other equipment are necessary.

To install the "Violite" adapter it is necessary only to remove the cap at the bottom of a standard 14-in. "Sollux" globe and screw the adapter into the socket of the regular lighting lamp. The reflector at the bottom of the adapter closes the hole in the bottom of the globe.

The ballast lamp in the adapter occupies the proper position in the globe and hence the user gets well diffused general illumination, plus the health-maintaining ultra-violet radiations. It is estimated that a daily exposure to an average installation of this type of dual-purpose lighting equipment is equvalent to approximately fifteen minutes of the rays from a therapeutic floor lamp.

Low-Temperature Fuse Links for Distribution Cutouts

A line of low-temperature, high-speed fuse links with distinctly new characteristics for expulsion cutouts of both the porcelain-inclosed type and the open type is announced by the General Electric Company. Successful performance of these fuse links in many installations has proved their superior qualities, it is claimed.

Some of the outstanding features are: Low operating temperature when carrying current, 40 per cent cooler than ordinary fuses even up to 100 per cent rated current; high speed—faster than oil circuit breaker relays even with close settings; high interrupting capacity—they easily clear high currents without sacrificing expulsion action required to clear low current and improved operation at low currents—the 1- to 20-amp. fuse links will clear the circuit quickly even at currents just high enough to melt the fusible section; the 25- to 150-amp. fuse links will clear the circuit quickly with small excess currents.

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Welding Electrodes with Heavy Mineral Coating

Arc-welding electrodes which have a heavy all-mineral flux coating have been placed on the market by the Metal & Thermit Corporation, sales agent for the American Murex Corporation, the manufacturer. These electrodes, known as "Murex," are 18 in. long and made in types and sizes suitable for a wide range of horizontal, vertical and overhead welding operation.

One of the features of the electrode is a patented spiral winding of asbestos yarn which serves to hold the heavy mineral flux to the core so that it is not injured if the electrode is bent. Among the eight types which are included in the "Murex" line are electrodes for welding commercial mild steel, manganese steel, 18-8 stainless and stainless iron.

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A SMALL, INEXPENSIVE LILY-POND ELECTRIC FOUNTAIN with mobile colors is announced by the General Electric Company. The basin of the three-projector unit can be constructed in any form which harmonizes with the surroundings; the water effects can be adjusted to any desired height, and recirculation of water conserves the outside supply. Color is provided by submergible floodlight projectors, automatically controlled to provide seven combinations of color in a one-minute cycle.